

# Aviation Week & Space Technology

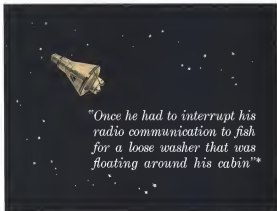
July 16, 1962

Sensors Planned  
For Apollo  
Rendezvous

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Vertol 107-2 in USAF Markings





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\*The Atlantic Journal 4/26/52

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stages have been streamlined and are being used in various combinations to create specialized vehicles for specific jobs. Scout was the first solid fuel vehicle to orbit a scientific payload and it has been used successfully in missions varying from re-entry to sounding studies. But then Clark can't resist what he's present. He and his staff are now devising ways to enhance Scout vehicles for missions that are still in the conceptual stage. By combining this caliber of management in depth, with proved technical competence in aerospace electronics, communications, and consumer products, LTV is furthering U.S. progress, defense and national well-being.

LINE-TEMCO-VOUGHT, INC. **LTV** DALLAS, TEXAS

## AEROSPACE CALENDAR

- July 23-25—Business Intelligence and Advanced Planning Seminar, San Francisco, Calif. Systems Operations Research, Inc.
- July 24-Aug. 2—National Science Convention, St. Louis, Mo. Ciba, Inc. Information National Science Conferences, P.O. Box 927, Victoria, Calif.
- Aug. 1-5—Engineering Foundation's Engineering Research Conference on Composite Materials, Texas School, T.A.M.U., N.H.
- Aug. 13—Experimental Aircraft Assn. Fly-In Rockford Airport, Rockford, Ill.
- Aug. 16-18—Civil Aeronautics Technical Symposium, Society of Aerospace Engineers (Texas Branch) in cooperation with the Air Force Systems Command, Suite 1411, New Hotel, New York, N.Y.
- Aug. 20—Lunar Landing Workshop, Conference, Texas Western College, El Paso, Tex. American Astronautical Society, U.S. Army Signal School Support Agency, Aug. 4 Session in Dallas.
- Aug. 29—PSTC (Program Evaluation and Review Technique) and CFM (Critical Path Method) Seminar, ITT Data Processing Center, Paramus, N.Y.
- Aug. 29—57th Meeting, National Aerospace Standards Committee, AIAA, Aerospace Products Hotel, Seattle, Wash.
- Aug. 3-16—1967 Standards Laboratory Conference, National Bureau of Standards, Boulder Laboratories, Boulder, Colo.
- Aug. 13-15—US National Operations Meeting, Men Machine Computers, Glynn Hotel, Seattle, Wash.

(Continued on page 7)

## AVIATION WEEK and Space Technology

July 16, 1968  
Vol. 77, No. 3

Aviation Week and Space Technology is a leading authority on the latest developments in the aerospace industry. This issue contains a wealth of information on the latest in aircraft design, space exploration, and the future of flight. The article "The Future of Flight" by John H. Davenport discusses the challenges and opportunities facing the aerospace industry in the coming decades. Other articles include "Space Exploration: The Next Frontier" by Robert A. Frosch, "The Role of Computers in Aerospace" by John H. Davenport, and "The Future of Flight" by John H. Davenport. The issue also features a special section on "Space Exploration" with articles on the latest in space technology and the future of space exploration.

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Aug. 31 Sept. 5—Sixth World Prochasing  
Championships Group: Max Spawer,  
National Amateur Assn.; Parach.  
Club of America.

Aug. 18 HotPac/Energy Conversion Co.  
Institute, American Institute of Electrical  
Engineers, Fairmont Hotel, San Francisco

Aug. 13-16—Seventh Symposium on Ballistic Missile and Space Technology, U. S. Air Force Academy, Colorado Springs, Colo.

Aug. 14-16—Cryogenic Engineering Center  
stars, University of California at Los An-  
geles, Los Angeles, Calif.

Aug. 14-17—International Conference on  
Pyroelectric Electroacoustic Measurements,  
Boulder Laboratories, National Bureau of  
Standards, Boulder, Colo.

Aug. 15-17—Nuclear Propulsion Conference, Monterey, Calif. (Joint Young Institute of the Aerospace Sciences, Univ. of Calif., Boulder, Colo.; American Nuclear Society, New York, N.Y.)

Aug. 25-27—Third International Electronic Circuit Packaging Symposium, University

Aug. 24-29—Lafayette Escadrille, Lafayette Flying Corps and Aviators of the French Foreign Legion, 1st Bureau Air-

show, Battle Creek, Mich.  
Aug. 1975—Annual Meeting and Conference,  
Airport Operations Council, Phoenix  
Keweenaw Hotel, Honolulu, Hawaii

Aug. 26-Tolworth Symposium, Pacific  
Entomological Membership Assn., San  
Jo. Hills Hotel, Los Angeles, Calif.  
Aug. 27-28-29, 1966, Entomology, 1966

Aug. 31, 1965—Radio Symposium on  
Conference Institute of Radio Engineers,  
Los Angeles, Calif.

The Island Spectroscopy Module (ISM) will be used to study the effects of space radiation on the human body. The module will be used to study the effects of space radiation on the human body.

Aug. 20-Sept. 17-19th Session: Internat-  
ional Civil Aviation Organization As-  
sembly, Rome, Italy  
Aug. 21-24-Chautauque, Burnside, Virginia

Aug. 20-26—Conference on The 14th  
Colorado State Highway Survey

**Conductors:** Giovanni Sgambato, Carlo  
Spencer Solid State Electronics Labora-  
tory, University of Geneva's Research In-  
stitute

Aug. 27-28-29-30-31-Third International Conference on Advanced Electronic Materials Being Held in Philadelphia, Pa.  
Aug. 27-Sept. 1-Third International Con-

Ang. 17 Sept. 3—Second International Congress

Aug. 24-30—Fourth Conference on New  
Frontiers of Blackness Movement, The

University of Colorado, Boulder, Colorado, U.S.A.  
 from: Indianan, Spain in cooperation  
 with Department of Defense, University  
 of Colorado, Boulder, Colo.

(Continued on page 9)



(Dr. A new slant on  $q$ -factoriality)

Heat exchanger design problems are reputed to make young men grey and older men baldier. It thus goes as a joy to report that fluid heat transfer engineers are today retaining whatever sexual prowess they started with. You can profit thereby.

Build often complete designs, prototype and production services for plate-fin heat exchangers. We produce these compact, lightweight and highly efficient components by both dip-brazing and epoxy bonding — with aluminum, stainless steel, copper and other materials — in myriad configurations for waste cooling, intercoolers, oil coolers, air conditioning systems and other land, sea, air and space applications.

What's new about that? Just this: To design the best heat exchanger for a given job, a number of completely interrelated thermal variables—heat transfer rate, thermal conductance, transfer area, hot- and cold-side temperatures, etc.—are usually jiggered around until the required heat transfer rate is attained. (Saving time below, the designer must also find a way to include such vital external requirements as area, weight, strength, reliability and cost.

We now announce, as readily as possible under the circumstances, that Baid is applying new techniques that enable plate-fin component heat exchangers to be designed and produced faster than ever before!

This is not the result of an oversight inspection. Our Environmental Control Systems Department has long been busy with a fresh and demanding investigation of an

lytical approaches to heat exchanger design. Their study was partially abridged by the experience, the knowledge of practical operating conditions, and the voluminous test data we've accumulated in over 28 years of designing and producing complete heat exchanger systems, as well as component exchangers and other types of environmental control systems.

Our new design method enables us to fix optimum exchanger relationships and values with surprising speed. In several recent cases, we've designed complex new exchangers in a few hours!

How can we do it? The details we need. But we can say that design reliability as well as speed is assured by a pre-specified feedback checking technique. (In a moment of false hope, we tagged the new method "Feedback-Controlled Design.") It may stick. Or other enticing information is contained in our first-to-change bulletin, which will naturally not be repeated. (If you don't already belong to The Bend Electronics Club or Mailbox Monthly, be sure to ask for your membership card right now.)

There is, of course, an eminently scientific way to verify our radioisotopic claims—let us dump and deliver your next exchange. Why wait? Environmental Control Systems, Radio Electronics, 43-22 Queens St., Long Island City 1, N.Y.

[illegible]

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patible and are available individually as well. It's the ideal system for executive jets and short-haul aircraft—as well as for high-performance transports and practically anything else that flies. Come in, please. The PB-60 Autopilot has been awarded for the Lockheed C-141 jet transports. The same system will be installed on the Douglas F-15 fighter aircraft.

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Airborne dust can be a long-time problem when it separates magnetic tape from signal, now from accurately recorded data. Then danger mounts as today's higher tape speeds and sensitive, precise, more and more dust-attracting wave electronics. That's one reason why high-speed recorders need "SCOTCH" brand Heavy Duty Instrumentation Tapes... they provide 1000 times greater conductivity than ordinary tapes. Drain off static charges before they cause trouble!

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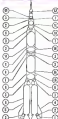
only 100 megohms per square or less. Static is readily dissipated to keep tape clean, prevent such other static problems as tape drag and flapping, as well as noise induced by arcing.

"SCOTCH" Heavy Duty Tapes outwear conventional tapes at least 15 times. Special binder seal high efficiency oxide formulation defies heat-hot buildup, withstands temperatures from -60°F to as high as 250°F. Solvent lubrication prevents recorder heads and tape against wear. In addition, "SCOTCH" Heavy Duty Instrumentation Tapes offer a variety of backing and coating thicknesses, provide constructions for all high speed applications, even for extreme high frequencies, critical short wavelength requirements. For details, call the 3M representative, or write Magnetic Products Division, Dept. MCA-71, 3M Company, St. Paul, MN.



\*BASED ON THE VALUE OF THE HEAVY DUTY STATIC COATING. THE VALUE OF THE TAPE IS NOT INCLUDED IN THIS CALCULATION.

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- 6. Molded case liners
- 5. Stabilizers
- 4. Thrust vector control systems
- 3. Large and small sleeve nozzles
- 2. Nozzle structures



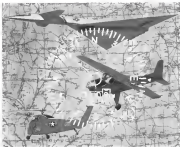
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Illustration ARN-65 TACAN by day (upper) and by night (lower) on an ARN-65 DME source. It is a 1000 ft. high aircraft, suitable for all AGREE.



*Of interest to engineers and scientists*



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- To investigate the apparent existence of a world-wide semi-annual variation in the occurrence of polar cap absorption events; to determine the frequency and time-intensity of solar cosmic ray events; to correlate North and South Pole riometer measurements and study differences in the polar ionosphere; to study the effects of radiation on ionospheric parameters.

The program will continue through the next solar sunspot minimum in 1969. Among other aspects, it will be useful in setting up criteria for the protection of astronauts from radiation.

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## EDITORIAL

### A Bold Decision

National Aeronautics and Space Administration has made a bold decision to push for lunar orbital rendezvous as its primary method of landing men on the moon and returning them safely to earth within this decade. The decision was made unanimously by NASA's Manned Space Flight management council headed by Dr. Buzzor Holmes (AV July 2, p. 37, July 9, p. 25), with the first conviction that this technique offers the best possibility for executing the lunar mission substantially sooner than any of the other admittedly feasible techniques, such as earth orbital rendezvous using a liquid oxygen tanker or the direct ascent. Yet the NASA decision makes a good deal of flexibility by allowing additional capability for direct ascent with hardware already under development (see p. 32), and bolstering the lunar rendezvous operation with a special logistics vehicle to support the astronauts on the lunar surface. And it has finally found a firm place in the space launch vehicle spectrum for the much-lamented Nova booster, now aimed at having two to three times the payload capacity of Saturn C-5. Nova's development will be deferred from an early lunar mission booster to a support role for later and larger solid-fuel and suborbital launchers.

The NASA lunar rendezvous decision offers several significant clues as to how the U.S. space program is moving now, in contrast to its earlier years. It provides some tangible evidence of the ineffable spirit we found infusing the working levels of NASA and its aerospace industry support during the preparation of the special July 2 issue of *Aerospace Week & Space Technology*, "NASA—Spurred to Space."

### NASA's Progress

First, the basic concept of lunar orbital rendezvous is an idea that was little more than a gleam in the eye of Langley Research Center's John H. Doolittle when President Kennedy established the lunar landing as a national goal nearly 14 months ago. Second, its daring development arose as a full-blown, well-considered strategy, not a hasty decision. Third, it was the result of a long, arduous, and often contentious process of the imaginative, established industrial units that characterize this area of NASA's activities today. Third, the decision-making process that was carried out in its months of the toughest type of technical arguments and rebuttal, and resulted in the unanimous verdict to go too promptly to lunar orbital rendezvous is a good example of the speed and courage with which the NASA managers are moving to reach their presidentially assigned goal.

A manned voyage to the moon is certainly a risky enterprise and no national space program is going to land its astronauts there first without taking some carefully calculated gambles. The lunar orbital rendezvous decision is this type of bold action, based on a reasonably sound technology base still spiced with considerable

risk, that has been a hallmark of U.S. success in the past and should continue to spur its future development. It is a complete rejection of the ultra-conservative technical philosophies that inhibited the growth of new technology so successfully during the late fifties.

The lunar orbital rendezvous decision implies four basically new technical requirements on the aerospace industry. They are:

- Development of the two-man lunar bag for landing on the moon from the Apollo mother ship in lunar orbit and making a rendezvous with that ship after brief take-off for the return trip to earth.
- Development of a logistic support vehicle to deposit food, oxygen and other supplies on the lunar surface for use by the astronauts landed by lunar bag.
- Development of increased power from the currently planned Saturn C-5 stage and development of a much lighter two-man Apollo command and service module for a possible direct ascent to the moon as the great lunar orbital rendezvous fails.
- Development of a huge super-Nova type space booster with the ability to boost several hundred thousand pounds of payload to escape velocity.

### Tremendous Task

In addition, the aerospace industry, along with the NASA program managers, have a tremendous task to develop in the Apollo and Saturn hardware already contracted for a technological excellence and operational reliability beyond anything yet achieved.

It was also a surprising change to witness of manned space flight press conferences in Red NASA Administrator James E. Webb with his three top managers in the area—Dr. Robert C. Seamans, Jr., Dr. Holmes and Dr. Joseph Shea—expand directly to their audience without the benefit of a public relations-type interlocutor whose technical accuracy and order failed to match that of the principals. These three relatively young NASA managers did a particularly laud job of explaining the details of lunar orbital rendezvous, the reasons that evolved into their basic decision and the philosophy with which they intend to execute the manned lunar landing mission.

The lunar orbital rendezvous decision is certainly a bold one. The ultimate proof of its wisdom, of course, must wait until the latter half of this decade when the race to the moon between the U.S. and the USSR will enter the final stretch. A final tie will probably be forthcoming in 1965 when the basic elements of the lunar orbital rendezvous mission will get a thorough operational testing in earth orbital flight.

But yes, live or die NASA's lunar orbital rendezvous decision opens a basic, new possibility for achieving success with the lunar landing mission and increases the odds substantially in the U.S. winning the race.

—Robert Flota





**HOW DO YOU KEEP THE PEACE WHEN EVERYONE HAS A KEY?** This is the challenge given Bendix by the United States Arms Control and Disarmament Agency in its first contract to industry. Our assignment is to study on-site and remote techniques to monitor declared arms production and to detect clandestine production of strategic weapons such as long-range missiles and bombers. Such techniques could be implemented by an inspectorate established pursuant to an arms control or disarmament agreement. Scientists with experience and knowledge of international economy, industry, transportation or political science as well as operations analysts interested in joining this expanding area, write or call Personnel Director, Bendix Systems Division, Ann Arbor, Michigan—an equal opportunity employer.

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## Washington Roundup

### Space Committee Shifts

House space committee is about to be reorganized along lines which will enable the National Bureau of Standards and National Science Foundation to share the public spotlight with the National Aeronautics and Space Administration.

Reorganization will be followed by the departure from Congress of the committee's third ranking Democrat—Rep. Victor Anderson. He will return to Florida to run for city judge and is likely to be sponsored there by a Federal judge.

Rep. Anderson's congressional district has been merged with that of Rep. John Rosten, a Democrat who has served in Congress since 1945. Kennedy Administration officials, whose political dealings showed Rep. Rosten the likely loss in a contest with Rep. Anderson, persuaded Rep. Anderson to withdraw from the congressional race and resume his judicial career.

Departure of Rep. Anderson, who headed the subcommittee which reviewed NASA's research budget this year, elevates Rep. Eardley P. Doolittle to the subcommittee leadership. Commerce Chairman George Miller intends to name Reps. Cliff Torrance and Joseph Keith chairman and vice chairman, respectively, of a NASA subcommittee. Reps. Roy Helvering and Doolittle will head the new Bureau of Standards and Science Foundation subcommittee. Rep. Miller also is considering having still another new subcommittee to investigate issues in this developing area of science on any one field.

The reorganization is designed to keep space opportunities in perspective while explaining the government's other important but underfunded scientific projects.

### McNamara Challenged

Defense Secretary Robert McNamara's passion to reduce military costs by \$5 billion a year (see p. 34) did not particularly impress Chairman Edward Hebert of the House Armed Services Investigative Subcommittee. Rep. Hebert in a recent four-page letter to McNamara and the House Government Committee estimated annual savings of \$4 billion if Defense covered the 1972 Defense Cartelizing and Standardization Act. Rep. Hebert listed other savings, drawing from congressional actions and said he was "getting a little tired of hearing speeches by politicians' speeches, article abstracts, study groups and papers from the secret and most expensive lab studies by non-profit organizations."

House space committee will ponder ways to save money in the national space program in hearings slated to start next week. Besides as well as government views are being solicited, inquiries come from the traditionally conservative House Rules Committee, which asked the space committee to find ways to reduce costs.

### Dr. Wiesner's Stand

NASA declined to frugal management of the lunar reconnaissance distance (see p. 32) for a week to satisfy Dr. Jerome Wiesner, White House science adviser, who felt he and the President's Science Advisory Committee should be given time to study the proposal.

President Kennedy last week nominated Wiesner as director of the newly established Office of Science and Technology, which will try to coordinate federal research activities. Once Wiesner is confirmed by the Senate, a House Government Operations subcommittee will question him on such proposed Budget Bureau reforms as redirect control of the science pool by private firms doing federal research (AW Feb. 9, p. 15).

House resources committee hearings July 17 and 18 on current news will consist mostly of electrified politicians from the Chicago area complaining about the case from O'Hare International Airport. The aeronautics and legislation groups subcommittees will sit mostly for the hearings. The full committee has been directed by a House resolution to file its current news report by the end of the congressional session. But the vote to adjourn probably rules out hearings on referenced problems and solutions (AW Apr. 16, p. 38).

### Contractors' Protest

NASA is trying to show a better picture of where space dollars are going by requiring prime contractors to list the names and addresses of their subcontractors. But contractors argue this is more government paper work. Over a dozen of them already have visited the Budget Bureau, which must approve the survey, to protest the plan. All NASA wants the contractors to do a list in a potential saving eight quarters about their subcontracts of \$10,000 or more.

Senate and House relations leaders are discussing a compromise bill to authorize government guaranteed loans for aircraft production of up to \$18 million for a single local aircraft carrier and up to \$15 million for a cargo carrier. The House motion also recently approved a bill giving the boys guarantee loans from the private \$5 million to \$20 million, but did not include the authority to include cargo carriers.

—Washington Staff



**QUALITY OF PICTURES RELAYED BY TELSTAR** compares directly with television pictures received from commercial ground stations. Vice President Lyndon Johnson, left, talks by phone with AT&T officials in his picture is relayed on the satellite. Right, still photo of Telstar was relayed through the satellite.



## Telstar Performs Perfectly in Early Tests

First active communication satellite transmits live television and voice between U.S. and France, Britain.

By Philip J. Klaus

Washington—Bell System's Telstar active communication satellite has worked perfectly in its first operational experiment, transmitting for the first time live television over intercontinental distances between Andover, Maine, and stations in France and Britain.

The French station at Pleumeur Bodieu in Brittany, using a large horn antenna identical to the one installed at the Bell System's Andover facility, was the first of the two distant stations to receive the Telstar television signal. It reported the quality of the received picture to be comparable to that from local French stations.

Twenty-five hours later, during Telstar's 19th orbit, the French station transmitted a taped, heavily repeated French station program which was received on the satellite both in the U.S. and in Britain. The program was carried live by two of the U.S. circuits.

Quality of the picture received here was excellent, despite concern from the French 600-line raster to the 525-line raster in the U.S. Program material included remarks by Jacques Mitterrand, secretary of post and telecommunications, and performances by several French entertainers.

On Telstar's next orbit, the French station over the French satellite which they had relayed as agreed between the two nations, beamed a live program to the U.S. Most observers agreed that the British telstar, largely a duplicate of atmospheric television by a ground communication facility, was technologically superior to the French pro-

gram, although not as fresh as a broadcast. During the initial experiment the 170 ft., 34 in. dish Telstar pointed 17 min. of uninterrupted, high-quality service, relaying live television and voice between Andover and government officials assembled here for the demonstration. Local lines provided the link between Washington and Andover, with signals being relayed by Telstar to complete the connection.

The satellite was launched by a Navaroc Aerocraft and Space Administration at 8:35 a.m. EDT July 10 from Atlantic Mobile Navy by a ThorDelta vehicle into a 44.7 deg. southeast or direct orbit which matched program objectives with extreme precision. Initial data from NASA tracking network indicated an apogee of 3,100 mi and a perigee of 290 mi, giving a period of 173.3 min. The cost of the launch was approximately \$2.2 million, was paid for by American Telephone and Telegraph

which also built the satellite at its own expense.

Telstar first came within range of Andover and the French station during its fifth orbit and its telemetry signals were received by both but the satellite was too close to the radio horizon to permit operational use.

During the sixth orbit, at 7:17 p.m. EDT, the Telstar tracking beacon signal was acquired by Andover. Three minutes later after outburst of signals indicated the satellite was ready for operation, the command was transmitted which applied power to the satellite's traveling wave (antenna) tube. At 7:35 p.m. the station transmitted up the first test pattern signal which was broadcast back satisfactorily.

At 7:28 p.m., after several minutes of adjusting the ground circuitry to compensate for Doppler shift due to satellite velocity, Frederick Kappell, chairman of AT&T made the first live telephone call via satellite to Vice President Lyndon Johnson in Washington. The conversation began "Good evening, Mr. Vice President, this is Fred Kappell speaking from Andover. This is the first call from earth station through Telstar." Johnson's reply was carried directly by land line circuits and not relayed through Telstar.

Next, a tape-recorded view of the Andover facility, with the Aerostar flying in the foreground, became the first television picture to be relayed via communication satellite. This, in turn, was followed by a live television interview with Federal Communications Commission Newton Minow at An-

dover, and later by two interviews with NASA Administrator James E. Webb and congressional leaders here. A major portion of the program was relayed in the commercial television network.

At 7:45 p.m., as Telstar was approaching Spain, the French station reported that its acquisition antenna had picked up the satellite tracking beacon. Two minutes later the French station reported it was receiving the Telstar picture and voice signals.

The French station, which has a less sensitive antenna, first received the Telstar signal at 8:00 p.m. in Sherbilly, France. Andover transmitted a favorable photograph of the satellite which was acquired by the British and French stations.

At approximately 8:04 p.m., the first sign of voice due to pick-up of earth station was heard in the Telstar audio signal, indicating that the satellite was leaving the radio horizon. About a minute later there were conversations, inter-upted. At 8:56 p.m. the Andover station transmitted the command which shut down the satellite. The last signal was received several minutes later. It was —9 min. longer than had been anticipated from early computations.

Telstar was sighted by the Andover station during its next orbit at approximately 10:10 p.m. and was operated for approximately 36 min. during this pass, with transmissions limited to voice communications.

The Associated Press reporter had the opportunity to talk via the satellite for approximately 3 min. with another reporter located at Andover. The volume and intelligibility of the signal received in Washington indicated that a normally expected in local telephone conversations, with an evidence of even a certain fading.

Conversations were carried on in normal fashion. The only disturbing factor was the satellite's location and its over the horizon time. A telephone conversation is a normal conversation, a characteristic of which telephone users are generally unaware and it is obvious. When the user attempts that the device is not subject to great malfunctions, no variation in sound quality, normally.

Telemetry signals received from the communication satellite indicated that the attitude of its open area was almost precisely perpendicular to the ecliptic plane, as intended, according to Kappell. GPNP, who directed the Telstar program at Bell Telephone Laboratories, which designed and built the satellite, is scheduled for launch the first of three active communication satellites which NASA plans to launch during the next two months. The Project Atlas satellite, being built by Radio Corp. of America, is scheduled for launch this fall, while Science, intended to be placed in orbit at synchronous altitude of 22,300 mi.,



**TELSTAR COMMUNICATIONS SATELLITE** pointed closely transmitted from Andover, Mo. station then relayed them back either to Andover (1) or Holselid, N.J. (2). Last orbit relayed Andover with Washington, D.C. (3). Telstar transmitted television pictures from which which were received in England (4) and France (4). Below, Telstar puts in a two-minute and four-minute-controlled test stop the third stage of the Delta rocket at Cape Canaveral. The probe to its launch last week. After moved the satellite's position about the transmitting and receiving antennas and block all but one of each for pre-launch ground test of the satellite's communication path.





# USAF Balloon Achieves Endurance Mark

By Larry Wood

Washington—An F-105 superpressure balloon which is capable of maintaining a constant altitude without dropping ballast balls, set a new flight record for such balloons, aloft 30 days, during which it traveled from Bermuda to a point 1,200 mi. northwest of Honolulu in the Pacific Ocean.

The flight, the last of a series testing the strength of long duration balloons at high altitudes, was tracked by the Federal Communications Commission's tracking and recording network of radio stations employing high frequency direction-finding equipment. It was made at 65,000 ft.

One previous flight traveled east to west from Bermuda to San Juan in the Western Pacific in 19 days, a distance of more than 9,000 mi.

At their rate, the balloons could, until they reach their full size and thereafter maintain constant volume regardless of changes in external pressure.

In each case, the 50-lb payload consisted of a radio transmitter, inflating inflators, which transmitted data to the ground stations. Temperature and pressure of the filling gas were measured, altitude was recorded and once in the upper stratosphere was measured. One was considered a "near ascent" for getting the amount of solar and other radiation in the upper stratosphere.

A radio command receiver is also aboard to switch equipment on and off and eventually bring the balloon down. No attempt is made to recover balloons which come down at sea.

Scientists from the Air Force Cambridge Research Laboratories have been launching the 10-ft.-dia. balloons since only this year. One flight launched Apr. 26 from Chaco, Chile, traveled to

Cuba City, Utah, in 31 days at a sustained altitude of 70,000 ft.

The 65,000 to 70,000 ft. level is used because there is less wind velocity over most of the globe at these altitudes.

The principle of superpressure balloons is not new, but it wasn't until rough lightweight plastics were developed that they became practical. Most balloons of the superpressure type since World War 2 have been made of polyethylene. This material was found to be too heavy when made thick enough to make the internal pressure necessary for the superpressure flight.

## Two-Layer Lamination

Mylar, which is the trademark of a Du Pont polyethylene, proved to be the material that made the constant altitude balloons possible. It is 10 times as tough as polyethylene. The Mylar, 18 mils (0.018 in.) thick, is exploded in a two-layer lamination. This is necessary to prevent gas leakage of gas through molecular speed holes. The lamination to prevent the holes are not fused up with each other and make a more perfect seal. The layer weight is 40 lb.

The superpressure balloon is a sealed, virtually unbreakable plastic cell that will float at a constant density altitude despite fluctuations in temperature of the lifting gas (hydrogen) between day and night. Ordinarily, balloons have to drop ballast or add or subtract weights at night to maintain altitude at the gas cools.

The plastic cell retains all of the lifting gas without significant change in volume. Internal pressure rises, but it stays inside above the outside pressure. At floating altitude the thin films can be as high as 5,700 psi. This type of vehicle is more efficient than the conventional, rigid balloons. Since they need no ballast, they ex-

haust a limited only by loss of gas by permeation of the bag material. By acting as stable platforms for supporting equipment at the edge of space for prolonged periods, they can furnish more information than the short duration sounding balloons.

A evaluation of the sounding rocket and the superpressure balloon has been used in the past. The "Robin balloon" was raised from a sounding rocket at 250,000 ft. by inflating, resulting in the determination of wind direction and velocities at that altitude.

For launching at ground level, an balloon needs an excess of gas to lift its payload. When a conventional balloon is inflated where it first becomes fully inflated, it starts to "valve off" the excess gas and continues to rise until internal gas pressure and atmospheric pressure are equal, and the buoyant force of the displaced air equals the total weight of the balloon and its payload.

During the day the sun heats the gas, causing some to valve off. After sunset the gas cools by radiation and the balloon is compressed. This smaller volume of gas no longer supports the weight and the vehicle will descend unless ballast is dropped. The next day the balloon will rise to a higher level. A supply of ballast must be carried for each 24-hr. period. For long duration flights this would be prohibitively large.

The superpressure balloon is sealed. It has no means of valving gas. Since the balloon volume never changes and the weight is supported remains the same, the balloon always remains at an altitude of constant air density.

## Cloud Conditions

Cloud conditions can affect the internal pressure of the balloons. If it is floating over an area that is cloudless the night infrared radiation will to a great extent increase the lack of sun radiation. On the other hand, if there is a cloud cover below, the gas loses heat and the internal pressure drops. Thus, under some conditions there is little pressure variation, but under others the variation is greater.

In addition to high tensile strength, the balloon material must have the quality of being sealed tightly along its seams and holding that seal at the low temperatures encountered in the stratosphere, as well as at the higher temperatures at lower altitudes.

A series of tests in cold chambers proved that the best method of making the bag was to use two sheets of the plastic to form a laminate. The balloons were manufactured by the G. T. Schindler Co., Minneapolis.



## Army Takes Delivery on First HC-1B Helicopters



Pittsfield HC-1B Chinook helicopter to be delivered to the Army in test fleets at the Vought plant at Martins, Pa., prior to ferrying to Ft. Rucker, Ala. Shop No. 1 at the production line is the first to ship. Army sales officer, Vernon says, some orders on the Army have been placed by the Army and then placed by the Army in a second test program, as well as to the Army in the completion of the test program in production shops. Possible configuration of the UH-1H 1013 (see story) is shown below. Estimated gross weight 140,000 lb. (estimated fuel).



## New Depreciation Rules Aid Industry

Washington—Equipment depreciation proved for the aerospace industry will be reduced by as much as two years under a congressional law which became law last week by President Johnson. The new law will allow the U.S. aerospace plant.

Industry leaders Douglas Aircraft, which will gain a 34.4 billion increase in its deduction for depreciation during the first year of the reform.

The law for the world of equipment in the aerospace industry is now set at right years. Although in the past there has been no established time for the industry, as possible if less than 15 years. The same applies to new set for electronic equipment manufacturers.

For aircraft equipment manufacturers the law is set at 12 years, compared with an average of 15 years in the past.

Results under the reform may be taken by all companies whose tax returns were due July 15 or later.

There is a strong effect on the new accelerated depreciation provisions they must be recognized by accelerated equipment replacement programs.

Industry estimated a \$20-million reduction in the tax liability of the aerospace industry for the coming year under the new depreciation rules.

## NASA Studies New Mars Flyby Spacecraft

Several capabilities, lightweight solutions for two Marsener M spacecraft intended to be launched in 1984, are under study at Jet Propulsion Laboratory, which manages National Aeronautics and Space Administration's planetary exploration program.

Consideration of a suborbiter Marsener which would be substantially lighter than the Marsener M spacecraft now in development as a JPL vehicle project, was made necessary by the long delays in the development of the anticipated Atlas-Centaur boost vehicle and in the likelihood that other versions of Centaur will be both overweight and under thrust.

Refined to be heavier as the Marsener M (M) is available, the suborbiter Marsener B spacecraft would weigh less than a total weight of between 410 and 530 lb, compared with the estimated 1,200 to 1,700 lb projected weight for a Marsener B vehicle. Marsener B is designed for Atlas-Centaur launch, but does Venus Mars capability and can carry a small planetary entry capsule. The lighter weight of Marsener M is intended to make possible use of one of a number of available launch vehicles, but most likely the Atlas-Agena B in 1984.

For the more serious of Centaur alternatives, JPL was forced last year to abandon its 1,100-lb Marsener A spacecraft, designed for Venus flights, the reason, at first, of the more limited 410-lb Atlas-Agena B. Estimated Marsener A cost 2,400, but the launch late this month and later this month, respectively.

The Marsener A and B vehicles are heavily overloaded basic Ranger spacecraft, but this vehicle would be suitable for a Mars mission because of sufficient electrical power and suitable temperature control.

In addition to the possible substitutes to the Marsener M spacecraft for the Mars exploration in 1984, for next Venus

shoot to take place in early 1984, upon will use the lightweight Atlas-Agena B launch vehicle. Marsener B project which was scheduled to start in 1984 possibly will be pushed back to the next Venus opportunity occurring in 1988.

Marsener M may carry a single station television camera as well as night and day color camera system. The camera station is expected to obtain close up photographs of the planet from a distance of between 10 to 15 kilometers from Mars during flyby. Television will be mounted on board the spacecraft, stored and then transmitted back to JPL's Deep Space Instrumentation Facility.

Features of the Marsener system are intended to provide a better understanding of the geology of the planet's surface as part of the overall objective of the Marsener program to study the planet's atmosphere, its composition and characteristics.

Besides the reason above and also shorter design, Marsener M can carry an advanced data relay system by sharing planetary position lines in the planet's atmosphere. Since two spacecraft are launched in close proximity at each selected planetary opportunity, in the Marsener program at least two Marsener M spacecraft would be built if a free decision is made to go ahead with this approach.

As a result of Centaur cancellation, it now appears possible that NASA and JPL will make these cost changes in its no new launch vehicle.

- Launch vehicle, which was proposed as a modified Saturn, currently is to be launched by Atlas-Centaur, with at least to be the Atlas-Agena B.
- Five Ranger spacecraft now are added to the backloaded Mars program to get additional insurance that a maximum amount of data about the moon can be obtained for the Apollo program. (AW July 25, p. 36). A number of proposals have been made for possible periods for these vehicles.

in going ahead with a Venus that can fly a payload less than 100 kg larger than that of the Venus-CV vehicle.

NASA's concern that attempts to carry a large payload to Venus to land telepresence mission beyond Apollo and to carry the logistic packages that would support extensive exploration of the inner surface, NASA

The Apollo program's Venus mission is the heaviest mission, Venus could be able to project to come vehicle payloads at least two to three times heavier than those that can be carried by a G-10. If it is possible, for example, to carry 240,000 lb in earth orbit or about 90,000 lb to come to Venus.

For this reason, Webb said, "we will not just get an out-of-the-way Venus mission but a heavily manned Venus mission." As formerly conceived by NASA, NASA's first stage would be powered by eight Redstone IV fly stages with a total thrust of 17 million lb. Its second stage would consist of four M-1 engines, a new liquid oxygen/glycoland hydrogen 2 million lb thrust power plant to be manufactured by Aerojet-General Corp.

Although NASA intends to continue M-1 development, the question of how to raise the program now being required and whether one is proposed in light of already pending in Congress.

delamination studies soon to get under way (see p. 29). Concerning NASA's weighing reduction of a program to develop a nuclear powered rocket stage to be used in the Venus mission.

Whether to develop a lunar impactor vehicle at the subject of still another NASA study (this is expected to come out in eight months). This vehicle might use gas-jet propulsion for the maneuvers on the moon, and also may be the first of a family of unmanned lunar landing craft that could collect scientific data on the physical conditions of the lunar surface.

## NASA Is Authorized \$3.8 Billion by Senate

Washington—Senate last week approved the bill authorizing the National Aeronautics and Space Administration to spend \$3,828,511,220 in fiscal 1963—an amount \$55 million above what the space agency originally requested. The bill also authorized the agency to be authorized (AW June 25, p. 36). The measure will be resolved in a conference between the Senate and House.

The Senate approved the NASA authorization bill and capped two annual appropriations for the National Aeronautics and Space Administration (AW June 25, p. 36). The bill authorized NASA to be authorized (AW June 25, p. 36). The measure will be resolved in a conference between the Senate and House.

Protestant and that without more cooperative building, NASA contracts would make both companies bigger and cost the nation unnecessary money. The NASA administration, under the current administration, would have a written plan. But since they have not been asked a contract by the government, the government is not going to be asked a contract by the government. The government is not going to be asked a contract by the government.

The noncompetitive amendment proposed by the Senate, which was approved by the President, would "conduct a study of the costs and benefits of the use of the U.S. aerospace and space efforts on U.S. scientific research development and education resources, with the intent of reference to the training and efficient use of scientific and engineering resources."

This was reported 32-12, after Chairman Robert S. Kerr (D-Okla.) of the Senate Aeronautics and Space Subcommittee and the President's

advisory board on aerospace education and training. The bill is expected to be passed in August, with the House already pending in Congress.

## Program Names Dropped

At Peter S. Putnam's Space Systems Division, he dropped completely the use of people names previously associated with specific programs. The following names have been substituted for those program code names:

• White (on-orbit defense alone system)	210A
• Star (satellite intercept)	210A
• Discoverer (space-based space exploration)	422A
• Explorer (space-based space exploration)	422A
• Titan (space-based space exploration)	422A
• Agena D (upper stage and spacecraft)	400A
• Reconnaissance (satellite space system)	500A
• Vela (Earth orbit for detection of nuclear fallout)	400A

The number designations were substituted in compliance with Public Affairs Council Circular 1338-13 issued by the military services in the Office of the Secretary of Defense.

For existing programs in Space Systems Division, this enforced simplification, aimed at clarifying identification of programs, is considered. Conversion of lettered SSN responses, that listing the program code numbers, with codes that are on space systems, telemetry designs, listing the program under popular names, results in a number of changes associated with code type of designation and other identification of the associated program code.

## NASA Procurement Total Rose 85% in First Half of Fiscal 1962

Washington—National Aeronautics and Space Administration last week reported an 85% increase in the dollar volume of procurement for the first half of fiscal 1962, compared with the same period in 1961.

The total, \$636 million for July-December 1961, was \$720 million more, than the \$946 million for July-December 1960.

NASA said 87% of the dollar volume of procurement was for the same period in 1961, or other agencies. The total was \$636 million for July-December 1961, was \$720 million more, than the \$946 million for July-December 1960.

Contracts and research grants to non-federal organizations accounted for 45% of NASA's procurement.

Contracts awarded to NASA in the summer 9% in advertising bid 42% in competitive acquisition and 49% in non-competitive acquisition.

The non-competitive awards were influenced by the fact that NASA's contracts were not placed for the first half of fiscal 1962.

Why larger share—53%—of NASA's contracts were not placed for the first half of fiscal 1962, was not explained for the first half of fiscal 1962, was not explained for the first half of fiscal 1962.

The largest NASA award during the first half of fiscal 1962 was for the development of a new rocket engine for the Saturn V, valued at \$100 million.

McDonnell Aircraft Corp. \$15 million for the development of a new rocket engine for the Saturn V, valued at \$100 million.

McDonnell Aircraft Corp. \$15 million for the development of a new rocket engine for the Saturn V, valued at \$100 million.

## New C-5, Spacecraft To Be Studied As Backup to Lunar Rendezvous

Washington—Development of a new two-man spacecraft and a space power unit, the Saturn C-5 vehicle in lunar orbit, is a major study at Jet Propulsion Laboratory, which manages National Aeronautics and Space Administration, at a backup technique for accomplishing manned lunar landing.

Although NASA continued last week that the Apollo lunar exploration mission would be based on the lunar orbit rendezvous technique (AW July 9, p. 17), it also said that direct ascent and other rendezvous would be the subject of continuing feasibility studies. But without making the new, relatively small spacecraft which in concept resembles the construction of Apollo more closely than that of the previous Gemini because it incorporates two modules.

NASA plans to report industry proposals this week on a lunar excursion vehicle—the log that would carry two men to the moon's surface, and return from the moon's surface, while the mother spacecraft remained in lunar orbit.

Proponents of direct ascent, which would be based on the lunar orbit rendezvous technique, are studying the possibility of using the Saturn C-5 vehicle in lunar orbit.

The Saturn C-5 vehicle is the largest of the Saturn family of rockets and is the largest of the Saturn family of rockets and is the largest of the Saturn family of rockets.

But without making the new, relatively small spacecraft which in concept resembles the construction of Apollo more closely than that of the previous Gemini because it incorporates two modules.

NASA plans to report industry proposals this week on a lunar excursion vehicle—the log that would carry two men to the moon's surface, and return from the moon's surface, while the mother spacecraft remained in lunar orbit.

## McNamara Says Economy Steps Could Save \$3 Billion Per Year

Washington—Defense Secretary Robert S. McNamara has outlined a series of actions he has taken that he said will lead to annual savings of \$3 billion per year through more efficient management, more competition in buying and elimination of duplication in procurement by the military services.

These economies are expected to save \$778 million in fiscal 1965 he said, and will work up to the \$3 billion figure in five years.

The savings would not necessarily result in a lower defense budget, he explained, but could be used to buy more military strength.

McNamara outlined his cost reduction program July 5 in a memorandum to President John F. Kennedy. At a press briefing he presented charts explaining various economy steps.

### Example Cited

An example cited in the services' inventory checklist: Excess stocks have been transferred to meet the needs of other services, rather than supplied through new procurement. In one instance, the Air Force needed inventory-placed bearings for use on overhaul of aircraft engines. The aircraft bearings were found in Navy stocks at a price of \$79 each.

The inventory transfer of these items resulted in a saving of \$26,000, the memorandum said. About 4,500 of these transfers took place monthly, it added.

Re-evaluating inventory levels, it was noted to exceed \$250 million in new procurement in fiscal 1962, the report stated, and greater reductions are anticipated in future years.

### Value Engineering

Early military service was encouraged to employ "value engineering" in which less valuable materials are used in place of more expensive ones. One example given was the H88-2 helicopter pilot seat. By outdesigning from use of steel to aluminum and changing the design, weight and price was reduced from \$54,475 to \$431.00. Material for a missile engine turbine wheel, with a designed service life of 2 years, was changed from machined titanium steel to molded plastic, achieving a price reduction from \$375.00 to \$2.00.

Numerous examples were cited of price reduction for replacement parts gained through competitive bidding. Among these were an aircraft sub-assembly which cost \$669.93 from a sole supply source and \$413.00 under competitive bidding, and an amphibious

vehicle whose price was reduced from \$48,000 to \$35,000.

McNamara said that the drive to reverse the trend toward greater use of cost-plus-fixed-fee contracts is succeeding.

This category reached a peak of 30% of all defense contracts in the first nine months of fiscal 1961, while during the corresponding period of fiscal 1962 it was 35.2%.

### Other Economy Moves

There are other areas which will produce savings, according to Defense Secretary McNamara:

- Simplification of purchasing procedures
- Standardization of accounting procedures. Those under the Defense Department, 16 different forms and systems are used, making the accuracy of recording 268,000 expenditures such as when one service buys from another service.
- Standardization of shipping documents. At present, 98 different bills of lading and invoices are used.
- Consolidation of all long-distance communications lead lines both in the U.S. and overseas. All military airwaves will be integrated.
- Freight route coordination through a Traffic Management Service.
- More efficient equipment maintenance through continuous analysis of costs per hour on aircraft.
- Release of old stocks and installations which do not meet present or future needs. Some 215,000 acres of land have been sold and returned to the public, 26 plants with commercial potential have been put up for sale and 42,000 personnel have either been released or reassigned.

## Infrared Beam Aids Space Communications

Important discovery which opens up an entirely new portion of the electromagnetic spectrum for long-distance communications, and which may permit communication with space satellites during re-entry when radio transmission is blocked out by an ionized plasma sheath, has been made at the Massachusetts Institute of Technology's Lincoln Laboratory.

Scientists there have presented an entirely new form of infrared radiation, with a communication bandwidth of at least 100 mc, by applying electric power to a gallium arsenide (semiconductor) diode. This is broad-

ly sufficient to handle 20 full-quality television channels or 38,000 voice channels.

The radiation produced is 160 megawatts wide, centered at a new infrared wavelength of 8,600 angstroms, when the diode is cooled in a liquid nitrogen bath.

At room temperature the radiation is about 100 angstroms wide and centered at about 9,500 Å.

Using an experimental set-up, Lincoln Laboratory scientists transmitted a high-quality TV picture over a distance of 275 ft., using the radiation first was produced by a gallium arsenide diode.

With modest refinements, range to 30 mi. or more appear possible. Because the beam energy is concentrated in a narrow portion of the spectrum, it can be used for daylight as well as night operations by employing optical films to exclude daylight except in the operating wavelength.

Unlike the laser (optical maser), the present gallium arsenide diode output is not coherent radiation. The signal is expressed as the beam by precisely modulation—by varying the magnitude of current flowing through the diode.

Both the power efficiency and conversion efficiency compare to the operating temperature of the diode is discussed. Experimental diodes used in tests have exhibited conversion efficiency of nearly 100% at a temperature of 77K, producing peak output power of about three watts. This is equivalent to a power density of 2,500 watts per square centimeter of diode working area, comparable to the infrared power of the sun's surface, but generated in a much narrower spectrum.

The new infrared generator overcomes the design of a communication system which can penetrate the ionized plasma sheath of a space capsule during re-entry, so the communication between space vehicles. Like infrared radiation generated by other means the energy is subject to attenuation by the atmosphere, particularly by clouds and precipitation.

However, the energy is generated in the unutilized region which radiates less attenuation than does utilized at larger wavelengths.

The new development might also find application in airborne proximity warning/collision avoidance systems. One of the problems associated with past attempts to develop an infrared anti-missile system has been the limited range achievable using previously available infrared sources.

First disclosure of the new discovery was made last week at the Solid State Device Research Conference in Durham, N. H., by R. J. Kren and T. M. Quarr of the Lincoln Laboratory applied physics group.



"Penetration 7 Shot, SR at Comrad." Illustrated by E. Z. Krenn for

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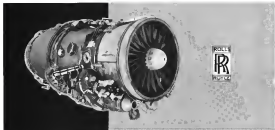
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# ROLLS-ROYCE SPEY BY-PASS JETS

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The Spey, based on twelve years of Rolls-Royce experience with by-pass (turbofan) jets, is now flying in the de Havilland Trident and has also been selected to power the new BAC One-Eleven. The Spey's economy of operation is an inherent factor in the low operating costs of these aircraft, both of which have already been ordered by well-known airlines.



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## Apollo Service Module Propulsion Test

First test of the Apollo service module propulsion system, developing more than 20,000 lb. thrust, was scheduled late last week at the Space Ground Corp. plant in Azusa, Calif. Flying duration was to exceed 5 min.

A hot-firing reason was to be first in the first test of the new service-propulsion engine, which Aerojet is developing under contract to National Aeronautics and Space Administration (NASA Apr. 25, p. 26).

The test had originally been planned for a week earlier but was delayed for more modifications to meet test requirements.

The Apollo service module engine is required to make a minimum of six starts per minute. It is intended to perform roll-over, guidance correction on the way to the moon, establish the lunar orbit, supply the velocity increment for earth return after recovery of the lunar landing vehicle, perform end-of-mission correction on the way back to earth, establish an earth orbit, and finally deliver the Apollo command module for reentry and landing.

Test burning time will be of less than 15 min. In operational usage, the propulsion tank design of different sizes may be considered. No design has been selected as yet, but it is under the engine that holds in its operational configuration.

Propellant combination is the most used in Test 2. The fuel is an equal mixture of hydrazine and unsymmetrical dimethyl hydrazine (UDMH), and oxidizer is nitrogen tetroxide. The nozzle shell is made of stainless steel, and nozzle cooling is by path, conduction and partly radiation.

## Spey By-Pass Engines Set for Fokker F-28

Amsterdam—Fokker Ltd. 175 14-to-60 passenger short-haul jet transport will be powered by two turbofan-engine-mounted Rolls-Royce Spey Junior jet engines with a maximum takeoff thrust of 5,050 lb each.

Selection of the Spey completes the final design parameters for the F-28 which could begin prototype flight testing in 1967 if government approval for the project can be obtained this summer (AW May 14, p. 15). The Dutch government now is considering a Fokker request for an estimated \$30 million needed to complete development work and carry the aircraft through prototype stage. An agreement this summer, Fokker says, would permit initial airline deliveries in 1966 under general scheduling.

Competitor of the British Jet Fokker competition was the British

Siddley BS75, which also is in the 5,000 lb thrust class. Maximum economies threat of the Spey Junior will be 7,540 lb.

A Fokker spokesman last week said that the two-engine configuration will be capable of lifting a fully loaded F-28 of approximately 50,000 lb maximum gross weight from runways of less than 5,000 ft in lengths or temperatures of up to 95°F.

## News Digest

Air Force Atlas B microencapsulated ballistic missile was fired from Vandenberg AFB, Calif., 7,800 mi to the Philippines, Sta. 704 on last of the March of Missions on July 17. This was the first reported SCIM fired over the Pacific Ocean, Range to reveal details, than Evacuated, SM-11, which is 5,500 mi from Vandenberg.

North American's Rocketdyne Division has secured letter contracts with an ultimate value of about \$228 million from National Aeronautics and Space Administration for further development and production of J-1 and J-2 rocket engines. Both are to be used in the Saturn C-5 launch vehicle, which will house the Apollo spacecraft into lunar orbit (see p. 37). Under the new contracts, Rocketdyne will deliver 15 J-1s and 50 J-2s between July, 1963, and August, 1965.

Additional research relating to aerothermoelastic data and design information necessary for the nuclear rocket propulsion system under development for a high-speed, low-altitude

vehicle concept will be conducted by Chrysler-Vought Division, Lang-Tenney-Vought, Dallas, Tex., under a \$2.5 million contract from NASA's Aeronautical Systems Division.

Prototype de Havilland DH125 test jet executive transport will roll out in about two weeks and first flight probably will be made in mid-August. Assembly unit has flown at least 10 ft in altitude for testing in the current Pan-Borough Air Show Sept. 1.

Two 20-tonne propulsion microencapsulated ballistic missile made its third successful test flight 5,500 mi down the Atlantic Missile Range July 13 into the extraterrestrial "space hole" near Azusa, Calif. in the South Atlantic Ocean.

Institute of Radio Engineers has voted to merge with the American Institute of Electrical Engineers by an 87% majority. The new organization brings professional engineering society in the world, will be called the Institute of Electrical and Electronic Engineers.

Arma Aircraft and Canadian Applied Research division of Hawker Siddeley of Canada Ltd. have been purchased by de Havilland Aircraft of Canada, Ltd. Hawker Siddeley will concentrate on other phases of its operations and will retain its Canada engine division and General aviation plant.

## Final Shynon Ruling

Washington—Defense Dept. K. McNair has been formally ruled suitable for maximum space flight because of his multiple test status, but National Aeronautics and Space Administration last week limited his use may be a case number in the new Great in these Air Apollo missions.

Final decision to proceed the Air Force escape from Mercury flights was made by Dr. Robert S. Gilchrist, director of NASA's Manned Spacecraft Center, of the Air Force's main test status was achieved by engineering Dr. Paul Douglas White, two years of test operations completed by Air Force and NASA's pilotless (AW June 15, p. 21).

Director's decision was that Maj. Shynon's condition, known as stress (Shynon), might prove a hazard under the "probably abnormal" circumstances of a test mission after flight operations. However, NASA Administrator James A. Webb and last week the Air Force is not being withheld as a condition for two or three more space missions and that the last decision will be made by the Air Force.

Meanwhile, Maj. Shynon is being engaged in planning and operational capabilities in several space flight research programs conducted by NASA.



## New England Senators Protest Quality of Service by Northeast

Washington—Eight New England senators last week announced they would not support Northeast Airlines in its attempt to renege its Florida agreement whereby, under that act, it agreed that New England will get better air service.

The senators were protesting the airline's attempt to cut losses on its New England routes by changing, on possible points of serving two or more low-density points through only one airport.

One of the group, Sen. Warren Magnuson (R-Wash. 5), told CAB Executive Officer William H. Webster that Florida (referred to) would be in the light of its effect on Northeast's New England operations (AW June 15, p. 42).

Without its Florida routes, Northeast might have to go out of business to receive subsidy.

### Hearing Recalled

At the recent hearing in the mixed-use case last July, Senator Magnuson and Northeast Airlines faced themselves in two capacities when they asked Brian for a 30- to 60-day postponement in order to bring their testimony and exhibits up to date. Brian said the second case hearings until Feb. 24.

Rafael, Lloyd Carter, attorney for Northeast, told Brian that Hughes Tool Co., whose control of Northeast has been approved (AW June 15, p. 46), had decided that itself to the program to revitalize the airline.

• **Source new bank loans guaranteed by Hughes Tool for the airline.**

• **Obtain extension of line credit on Northeast payments to secured creditors.**

• **Provide assured facilities to accept three to five new lines.**

• **Substantiate all claims Hughes Tool has against Northeast—over about \$11 million—in favor of the claims of unsecured creditors.**

• **Underwrite all cash deficit incurred by the airline after June 30.**

• **Northeast's principal creditors have until July 31 to approve the revitalization program.**

### Control Reverted Sought

In advised action last week, Eastern and National, as a technical effort to reverse the approval of Hughes Tool acquisition of Northeast, asked CAB to return, reconsider or permit intervention at the Northeast-Hughes Tool Control Case.

Eastern intended the Board that

under the Federal Aviation Act, control cases require a hearing, and cited the wording of the CAB order approving control of CAB last and "no matter what was done by the second, approval of Hughes Tool would be required." Since the alternatives were actually or bankruptcy in this situation, Eastern said, no hearing was necessary.

National said the law in the CAB and Hughes Tool case is in a "CAB position" that Northeast's survival is in the public interest. National said that program could have been economic if Hughes Tool's activities could be shown to be sufficiently appropriate in its carrying Hughes Tool's own agreement of Texas World Airlines in an active, private operation to Hughes Tool control of Northeast were never allowed that opportunity (AW June 15, p. 47).

## FAA Criticized for 707 Statement

Washington—Sen. Warren G. Magnuson charged that the Federal Aviation Agency "exceeded its statutory authority" when it said the loss of a rubber-belt airline bus has been a failure in the May 1 crash of a Boeing 707.

Under the Federal Aviation Act, said Civil Aeronautics Board is empowered to issue statements concerning the probable cause of an accident. Magnuson chairman of the Senate committee on Commerce and Science, said: "When individuals in government arrogate upon themselves authority not delegated to them, their words are wrong, accepted by the general public" because they "are with their own mouths."

Protesting Magnuson's remarks was an editorial bulletin issued by CAB on June 12 to all U.S. and international operators of the 707 (AW June 15, p. 37). This bulletin stated that the agency's investigation of the accident which took 95 lives, "indicates possibility, not probability, that left off momentary moment in control aircraft was not caused by left turn to misdirection of rubber-belt system."

Earlier in the message, George C. Pelt, director of FAA's Flight Standards Service, cautioned that a complete CAB investigation of the accident was in progress, and that the FAA had no intention of "to any attempt to prejudice CAB findings." Rather, Pelt said, it was to alert the airlines of FAA's intended action.

The FAA's policy Administrator N. E. Hilde, last but not excepted sharp

### Moscow-Cuba Route

Washington—Soviet Russia's international airline, Aeroflot, last week took the first step in its latest expansion to Moscow Havana air route. Plans for the route were originally reported by Aviation Week (AW May 6, 1961, p. 41) and later confirmed in Moscow by Aeroflot's chief, Colonel Gerasimov. The route was scheduled to start in July.

A passing flight, using the long-range Tu-114 transport, was scheduled last week between the two points last but was in preparation for regular service. The first such Atlantic crossing by the Soviet Union was made by the Tu-114 in April (AW June 15, p. 40) and the second Atlantic crossing was made by the Tu-114 in May (AW June 15, p. 40).

Related agreement between the U.S. and Russia had been reached by negotiation, but the U.S. withdrew when the Soviet Union refused to accept the Commission (AW Sept. 4, p. 49).

In October when Magnuson's committee charged that the FAA had exceeded its statutory authority, he said the agency's period of legislative power is over and the committee will consider FAA's status with greater attention.

First, he said, the FAA's authority depends on FAA's decisions. Magnuson said the agency was not "infallible" and that its activities "could contribute to an accident." Despite allegations to the truth he said, he said that the FAA would not be the subject of its own decisions, or the wisdom of its actions. "I would be sure," Congress, therefore, intended CAB with respect to, for investigating accidents so that the FAA would not be involved.

FAA has both the right and the duty to take prosecutive action when "acts of doubt" arise after an accident. Magnuson said. But he objected to the manner in which the agency had issued its bulletin and the statements that allegedly accompanied it. According to Magnuson, FAA's action was "incomplete, unbalanced, and lack of direction" for the following reasons:

• **Being issued through service bulletins** would create great saving operation to ensure the linkage between the FAA and the public.

• **Airline executives** have been misled by the FAA's statement that the factors and future actions, corrective action without further prompting.

• **Aviation executives** making active recommendations should have been used by the FAA to prevent problems of its company nature.

## Survey Questions Auto Traffic Potential

By James R. Ashlock

New York—Nationalwide survey indicates that another 17% in airline business might be diverted from automobile travel, but certain questions whether the potential profits the expense personal effort necessary to attract it.

Four airlines and two air carrier terms each contributed \$30,000 for the survey, conducted by Optima Research Corp. of Princeton, N. J. American, Eastern, TWA, United, Boeing and Douglas participated. Chairman of the survey's findings were based on a probability sampling obtained through 5,000 personal interviews conducted between Jan. 12 and Jan. 18.

The survey is considered a significant "first" because of an nationwide scope and the number of airlines participating. Market expansion studies heretofore usually have been limited to single-carrier studies (AW Dec. 25, p. 24).

Airline executives' survey's conclusions indicate, although not too encouraging. Only 1% of the auto travel is making trips over 600 mi. is considered likely for diversion to air travel, the 1% would represent domestic interstate passenger traffic alone is 3.5 billion, 3% more than the 30 billion currently flown each year.

Other conclusions of the survey in brief:

- **Approximately 42% of the 115 million auto population** made an auto trip of at least 400 mi. in 1961, while only 5% traveled by airline.
- **Total of 75% of auto travelers** and that would still go by auto, even if all road conditions were acceptable.
- **Only 34% of auto travelers** even considered air transportation.
- **Total of 46% of auto travelers** could not tolerate extended competitive routes by air and road trips of equal distance.
- **About 16% of those interviewed** expressed a fear of flying (AW May 21, p. 43). This figure, in turn, represents fear, however, is not a reflection of about fear. It is felt the figure could be profitably tripled in driving circumstances.

One often used industry figure shared by Optima Research's findings is the statement that each 32% of the nation's population has ever flown a over-represented airline. Survey shows that 27% have flown more than 2% more than 1% in 1961.

The largest single factor in the choice of auto travel over air is the availability of the car at destination an advantage cited in 54% of the responses.

Joseph C. Bove, chairman of the board of Optima Research, is doing

other serious travelers chose the auto and 41% listed driving companions along 30% of the auto trips. 35% stated to select their own schedules and 25% preferred the flexibility in trip and amount of luggage that can be carried by car.

"The airline facility up to this point should not wait the requirements of the auto traveler," Bove said. "Car travel is a not very much in the same manner of auto travelers."

Bove said it is obvious from the survey that most auto travelers have little conception of what their trip cost. Only 85% even included gasoline expenses, with little or no consideration of tolls, insurance, depreciation, lodging and food.

Twelve-hour car rest said they would do it and car costs were the same. But based on airline costs based on average 6 cents per mile, only 4% of those and the world's per cent fares and 1% of those who would pay more than half of current fares.

Bove admitted that compiling the questionnaire to satisfy all the participants, and thus drawing conclusions, was one of the most difficult tasks in his firm's 25-year history. He said the actual potential diversion from auto to air is perhaps more than 1% and could be as high as 3%.

The study is valuable in the joint consideration of its land and air modes.

As American Airlines spokesman said, "In conclusion that additional air travel cannot be created in reality, or in an economic sense, is not a very realistic view of it, or, of course, not encouraging. But the problem should not be regarded as insoluble."

TWA and a still new the automobile having pulled in a transportation "time of market." It will be a "joint objective" as the airline's estimated market expansion effort as a TWA spokesman said.

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jects to assure continuing advances in scientific knowledge, as well as in business systems and management methods. On-time delivery is one of the many benefits of the Division's advanced programming and control techniques.

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# Carriers Defend Non-Flying Businesses

By Wael Wright

Washington—Subsidized airlines are growth-oriented that a Civil Aeronautics Board proposal to encourage them to transport activities will lead to intense management and deal with one aspect of industry activity.

CAB stated the reforming to see whether "any significant non-transport activity" by a subsidized air carrier might.

• Create financial units which could "pursue its effective operations."

• Create problems "with regard to the allocation of expenses as between the air transportation and other activities of the carrier."

### Bardon on Carriers

Under the proposed policy, CAB would consider all non-transport activities of subsidized carriers prior to any act in the public interest when acting as carrier transactions. The carriers would have to go through a process.

If adopted, the policy could have a profound effect on the character of the subsidized airline industry depending on how the Board chose to use it. Most subsidized carriers feel a typical one might be in a state one involving two or more airlines. Those carriers involved in non-transport activities would not all other factors being equal, get the same value that could put a third carrier in the public interest.

In that way, some carriers fear CAB could force the industry into giving up all of its non-transport activities.

Right now, with a policy would directly affect an area of 15 local service airlines, one Hawaiian and at least three Alaskan carriers.

All have businesses other than strictly airline operations.

Examples of the expanding non-airline activities of subsidized carriers can be seen in CAB's current case.

• **Allegiance Airlines** recently organized a retail chain. Allegiance's airport car rental facilities are now in 15 cities at 15 of its growth on its route system. By 1971, Allegiance hopes to add up to 10 more car rental branches along its routes. The airline views car rental as a natural extension of its other operations.

"We see a distinction in airport," a company spokesman said. "The airline also performs some general aviation maintenance and overhaul, and plans to expand these services in the future."

• **Alaska Airlines** had local operations, including maintenance, flight school and dispatch for other carriers and gen-

eral aviation, and accessories, as well as the airline contract. Non-transport activities earned nearly \$730,000 for Alaska in 1961.

• **Bonanza Air Lines** instrument repair and maintenance services, sales and service at Phoenix. Bonanza also performs instrument checks on U.S. Staff's Fairchild F-77 at its Las Vegas shop.

• **Norfolk Air Lines** use of its shops for general aviation maintenance and work-on-airline activity which brought over \$355,000 for the last quarter of 1961.

• **Northwest Consolidated** and **Wien Alaska** submit lists of aircraft repair shops and hotels in Alaska. Wien also operates restaurant and bus services in connection with its hotel. Wien's non-transport activities net about \$500,000 annually.

• **Piedmont Airlines**, which operates Piedmont Airlines as a division and is the largest operator of general aviation shops in the local service industry. Piedmont performs maintenance and on-airline work on Lockheed Lodestar and smaller aircraft in its general aviation shops, services F-27, DC-3 and other smaller equipment in its airline shops.

Piedmont and its franchisees received about \$411,800 during the first quarter of 1961 and produced a \$694,000 reduction in brokerage cost between 1955 and 1960, thus relieving its airline requirements.

### Main Issue

The heart of the matter before CAB is whether public funds in the form of subsidies are being used by subsidized carriers to compete with non-subsidized businesses through non-airline activities.

### LOT Growth Slows

Massachusetts' state-owned airline, LOT, showed little growth in traffic last year and its route network expanded at least unchanged, according to latest data released by the state.

LOT now runs 11 new 131-672 passenger and 4342 route tons of cargo last year compared with 156,000 passengers in 1960. In a previous survey with **Wagon Wheel**, LOT officials showed 298,000 passengers were carried during 1960 (Jan. 14, 1961, p. 40).

The Public account current report suggests that its most recent problem is expansion at the **Wagon Wheel** airport. It made no mention of period-on-period plans for acquiring additional aircraft just transports and for becoming a transatlantic carrier in the 1963-1965 period.

In comments filed at CAB last month, several other ship operators not affiliated with an airline were concerned in stating that CAB adopt the policy. These operators are thus concerned with the loss of general aviation customers, particularly owners of large aircraft to ships caused by subsidized carriers.

Owners of large aircraft filed comments urging CAB not to adopt the policy, and that the Board consider whether inadequate for larger aircraft at some non-airline shops, or that the correct suitable non-airline shop run too far away for non-passengers.

Independent ship operators point out that airline shops have been able to use general aviation customers very well expanded facilities having their cargo directly or indirectly in subsidy from the government.

### Congressional Interest

Five congressmen filed comments urging adoption of the policy and several others asked Chairman Allen how to keep them out of the area of development in the proceeding.

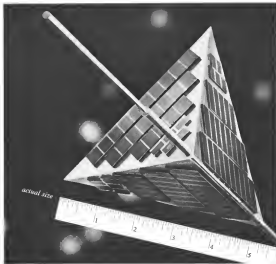
Several congressmen affiliated with the House and Sen. James H. Eastland (Miss.) chair of the subcommittee on Airports and Airway Development. He charged that Allegiance's car rental service derived from subsidy and amounted to unfair competition in a business already highly competitive.

The subsidized airlines argue that the subsidies, for instance, the use of equipment is essential to keeping good management. They feel that disbursement of a broader economic base from which to draw money to pay for transportation. CAB has set \$15,000 as the highest total economic aid that it will accept for which to disburse.

As for subsidies, several is concerned the carriers' subsidies that costs of non-transport activities are not included in the computation of the amount of subsidy to be paid. But when non-transport activities are profitable, the government stands to reclaim much subsidy.

Chief objection, the carriers say, is no case for concern. Allegiance says three or four CAB airlines spend approximately \$100 million more than other airlines checking such local service carriers books to make sure there is no more of gas cost subsidies.

Finally, subsidized carriers to the proposed policy attempted to delay because it amounts to an endorsement as a symptom of power in the Board's activities that are not intended to encourage the prohibition of the Federal Aviation Act.



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## SHORTLINES

► **American Airlines** now problem-free, simplified cable design within an ellipse bordered by an orange circle — still being appearing on ground equipment at Idlewild Airport this month and will eventually become standard throughout the airline.

► **California Automotive Corp.** of North Hollywood, has taken over controlling interest in Associated Air Transport of Miami. The airline will operate a fleet of Lockheed 740 and 1090C Constellation on passenger charter flights to Fort Lauderdale, Chicago and Burbank. San Francisco-Hawaii routes. An increased budget for this being used to further.

► **Capital Airways**, a U.S. supplemental carrier, has purchased five Boeing 650 turboprop airplanes from Whitworth Aircraft Co. Ltd. (AW May 28, p. 41), and is operating them as U.S. Air Force Lapar routes carrying national cargo. Capital is also negotiating for the purchase of two additional Lapars for possible use in commercial service. Terms of the sale were not disclosed.

► **Federal Bureau of Investigation** said it recently has investigated 3,675 false reports of bomb threats connected with aircraft since opening of the nation law in 1956. FBI and it identified 460 reports and presented 94, of which 47 were convicted and 37 went to jail for times of six months to a year.

► **Los Angeles Airways' May** traffic figures show a 58% increase in passenger traffic over May, 1961. Los Angeles Airlines the increase in passenger air transport of its 23-seat Sikorsky S-61 helicopters per day service last March.

► **Midwest Air Transport Service** has ordered \$30 million in contracts to six airlines for passenger and cargo services during Fiscal 1962. Of that total, \$20.3 million was awarded to U.S. Air Force. Larger operations and \$5.4 million for overseas work. Contracted to six airlines: Northwest Airlines, \$7.9 million; Eastern Airlines, \$7.1 million; Western Air Transport, \$6.4 million; Alaska Airlines, \$5.4 million.

► **United Air Lines** says it flew 18,615 passengers in June 20, which it claims is the first time in commercial aviation history that a carrier has topped 50,000. United said 5,771 passengers boarded at Chicago's O'Hare Airport for a single-day record for that city.

## AIRLINE OBSERVER

► **Cancellation of three** new 740 series 2-transport transports by BOAC for its subsidiary, **Adair Airways**, was made because the aircraft did not meet Adair operations at high altitude airports. Another factor not made public, is that BOAC this year is taking a hard look at its losses since the 740s would have cost about \$1.8 million. Orders for the 740s now stand at 20 for civil operations and between 10 to 40 for the Royal Air Force.

► **Positive control of terminal area traffic**, a major recommendation of the Project Business report on ATC, will begin Nov. 15 in Atlanta on a test base. Projected by Aviation Week (AW May 14, p. 50), this initial step toward sequencing controlled flow automated traffic at a major airport will be based on expanded use of radar and involve the airspace extending from sea level to 6,000 ft. Pilots of VFR aircraft entering the area are to report their position over prescribed checkpoints for sequencing with IFR traffic.

► **Versatile's rugged An-2** airplanes show little indication of taking from the Russian air transportation scene despite Soviet sanctions more than five years ago that they would "soon" be replaced by modern, than half-craft. This new Soviet carrier operating at Moscow, a large passenger-carrying aircraft based at Moscow, have been designed for service by the 12-passenger An-2.

► **Texas World Airlines** is reorganizing its sales organization through the creation of a new marketing division, which will replace the sales division and reduce all sales activities from the general sales office to the district level, and reorganize all scheduling and marketing activities. President J. McFadden, formerly National Broadcasting Co. vice president, has been elected vice president controlling to head the new division. Title of vice president and general sales manager, held by L. F. Mansfield, has been discontinued. Mansfield will continue as a vice president of TWA.

► **United's** extending civil air routes throughout Africa. Bilateral air transport agreements have been signed with seven of the 11 nations comprising Air Afrique: Ivory Coast, Senegal, Cameroon, Niger, Central African Republic and Benin. Congo, Mauritania, Acadia has negotiated its new route from Moscow to Basle via Rabat and Casablanca (AW June 25, p. 36).

► **Chicago's Midway Airport**, for years the world's busiest airport, last week, but its last scheduled airline flight. United Air Lines transferred its new mainline flight to O'Hare International Airport, leaving only private aircraft operations at Midway, which, on its last day in 1959, handled a total of landing every 51 sec.

► **Proposed reorganization of the Air Transport Assn.** is now under study by its airline members. The plan, which calls for dissolution of all conferences except the Air Traffic Conference, was presented to the board of directors at its last meeting, but it was felt that all ATA members should have, in capacity to consent to it. A new general board meeting is scheduled for December, but it is expected that a special meeting will be held in October after all airline conferences have been received, to vote on the proposed reorganization. Purpose of the plan is to permit the ATA staff to act in policy-making matters rather than serve the industry simply in a secretarial capacity. It has in the past, the directors are expected to approve a substantial restructuring plan for ATA.

► **U.S. transline traffic** showed a 12.2% improvement during the first six months of 1962, compared with the same period last year. Cross-country traffic accounted for 62.9% of all traffic during the first half of the year, compared with 57% in the corresponding period last year. Traffic increase showed in June, when it rose only 4% following regular monthly gains of about 10% since the first of the year. June load factor of 58.7%, although 21% below that of June, 1961, is the highest reported so far this year. Flight operations were again at Eastern Air Lines had a definite effect on overall passenger loads. Two of Eastern's chief executives, chief executive, National Airlines, were principal beneficiaries of the strike, with traffic gains of 35% and 30% respectively in June. Third competitor, Northeast, showed a decline in revenue passenger miles for June.



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Compiled by AVIATION WEEK from airline reports to the Civil Aviation Board. 1¢. Excludes various insurance.

### Airline Income and Expenses—April, 1966

	Passenger Revenue	U.S. Mail	Express	Freight	Charters	Total Operating Revenues	Total Operating Expenses	Net Operating Income
<b>DOMESTIC TRUNKS</b>								
American	34,166,377	839,658	429,849	2,219,233	.....	38,123,818	34,773,232	3,350,586
Continental	6,528,946	221,312	62,841	267,197	16,826	7,287,143	6,149,887	1,137,256
Eastern	10,111,111	368,822	34,800	1,000,000	.....	11,514,733	10,295,000	1,219,733
Delta	14,334,080	320,800	141,800	427,808	.....	15,223,688	13,695,860	1,527,828
Northwest	22,949,473	517,810	.....	1,571,743	23,133	24,561,159	23,141,792	1,419,367
Republic	2,438,322	.....	35,232	.....	.....	2,473,554	2,243,000	230,554
Southwest	4,271,243	45,378	28,940	157,331	.....	4,402,892	4,060,349	342,543
TWA	1,195,452	329,792	.....	505,498	13,308	1,844,050	1,707,135	136,915
United	21,822,222	349,448	.....	1,000,000	.....	23,171,670	21,450,000	1,721,670
Western	41,533,460	1,248,234	.....	2,814,937	234,217	45,590,648	43,501,528	2,089,120
Western	5,443,285	115,318	.....	290,639	48,258	5,897,490	5,285,700	611,790
<b>INTERNATIONAL</b>								
American	179,348	9,219	1,474	44,449	.....	208,537	192,534	16,003
Continental	487,749	25,311	.....	75,543	.....	563,603	505,568	58,035
Eastern	558,554	3,329	.....	38,157	36	606,756	545,211	61,545
Delta	1,011,111	3,000	.....	38,157	.....	1,052,268	950,000	102,268
Northwest	2,889,127	18,624	.....	148,578	6,249	3,062,344	2,741,974	320,370
Republic	153,181	.....	940	4,871	.....	158,992	146,023	12,969
Southwest	2,261,432	803,896	.....	73,581	244,720	3,083,729	2,748,348	335,381
TWA	28,331,080	3,048,080	.....	4,481,000	2,227,000	37,887,160	36,762,800	1,124,360
United	26,100,000	1,200,000	.....	1,200,000	.....	28,500,000	26,500,000	2,000,000
Western	1,324,656	1,230,000	.....	1,324,656	1,231,000	17,777,363	16,217,300	1,560,063
Western	7,962,300	388,000	.....	5,177,000	84,000	13,501,300	10,754,000	2,747,300
Western	1,478,000	1,413,000	.....	1,478,000	992,000	5,361,000	4,600,000	761,000
Western	1,222,000	63,000	.....	251,000	.....	1,536,000	1,214,000	322,000
South Pacific	34,554	1,384	.....	628	.....	36,566	34,424	2,142
Trans World	5,942,481	1,061,314	.....	694,137	84,731	7,782,663	6,891,754	890,909
United	2,017,264	114,384	.....	134,207	.....	2,265,861	1,820,884	444,977
Western	77,204	6,343	.....	55,136	.....	138,683	123,448	15,235
<b>LOCAL SERVICE</b>								
American	133,218	25,563	31,181	49,178	.....	218,140	177,920	40,220
Continental	809,477	3,460	3,789	10,468	.....	827,234	720,198	107,036
Eastern	1,011,111	.....	.....	1,011,111	.....	1,011,111	890,000	121,111
Delta	407,378	15,148	3,531	26,766	2,022	438,843	378,831	60,012
Northwest	1,044,444	11,139	14,444	15,667	3,748	1,089,338	968,000	121,338
Republic	204,444	.....	.....	204,444	.....	204,444	180,000	24,444
Southwest	1,218,556	27,798	32,280	41,164	.....	1,329,798	1,096,121	233,677
TWA	252,442	12,772	7,192	24,220	31	296,657	268,423	28,234
United	1,444,444	.....	.....	1,444,444	.....	1,444,444	1,218,000	226,4

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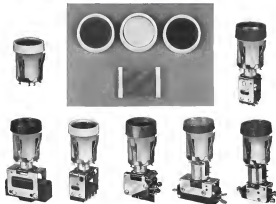
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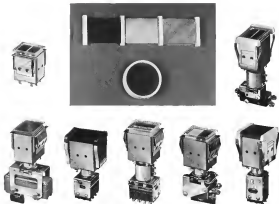


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**SOLID-STATE, K-BAND RADAR/TRANSPONDER SYSTEM** which does not contain tubes, being developed by Space Technology Laboratories, is shown in laboratory operation. Carrying maximum bandwidth in a curved tunnel radar dish and range find out on equipment on background. System already ranged 47,000 ft with an error of 128 ft.

## Radar, Infrared Studied for Rendezvous

By Barry Miller

**Los Angeles**—Growing number of aerospace companies are investigating and/or developing sensors, particularly radar and infrared/optical techniques for use by space vehicles in rendezvous both with freights and other vehicles in space.

These efforts partially are an outgrowth of government funded studies from space studies and the need for flight hardware for both civilian and military space vehicles. With the National Aeronautics and Space Administration's decision to use laser rendezvous techniques to speed the Apollo home program, substantial rendezvous radar development may be expected from industry.

Westinghouse currently is developing a rendezvous radar system (AW Apt 23, p. 26) to be delivered to NASA each next year for use in the Gemini program.

In addition, the need for reliable, high-performance sound-ranging sensor for military vehicles in programs like the Site-Site Inspector, or Sent (S2IA) program, and possible unarmored and unarmed follow-on, probably will stimulate further interest in

this field. In USAF Space System Division's recent short-term radar studies program (AW June 4, p. 34; June 25, p. 26) two studies for which Hughes Aircraft and Raytheon were picked as potential contractors were to have been devoted exclusively to sensor/guidance. Even without fused Air Force backing, a number of industrial and defense manufacturers are running rendezvous sensor efforts, such as in conjunction with unclassified space studies conducted by major spaceborne manufacturers. Hughes, for example, has been working with Martin Marietta and Boeing, investigating the latter with its Project STED4 autonomous weapon sensor studies (AW June 25, p. 26).

Sensor tasks as radar use be required in rendezvous missions to search for and acquire targets, supply range and velocity information during transfer of one space vehicle from its parking orbit into the orbit of its target vehicle, carrying out orbital guidance system and to supply closing guidance signals.

In recent months, Air Force has shown an interest in developing several sensor systems through several ongoing programs. These projects program in turn have aroused attention among sensor equipment manufactur-

ers and probably will lead to further rendezvous sensor efforts in industry. The programs include:

- Distance Measuring Sensor—Air Force Special Weapons Center** (Kirtland AFB, N.M.), asked for qualified sources late last month for the immediate test of distance measuring system capable of determining slant ranges between maneuverable platforms in an accuracy of 1 of 10. Systems, including guidance computer for both a sensor and slave stations, are sought. Master station equipment is set to cover 1,500 ft. and 50 cu ft. volume slave station equipment is to be held below 100 ft. and 10 cu ft.

- Target Seeker**—Conceptation to select two or three contractors to conduct studies of a target seeker that might be developed within five years to aid USAF inspectors within present and USAF targets was held this spring by Space Systems Division (AW Apr. 23, p. 99). Eighteen proposals representing many companies active in rendezvous sensors were submitted. The 18 are believed to include: Westinghouse and Emerson Electric which supply the long and closing range radar for USAF's current S2IA vehicles; Raytheon, Sperry Rand, Hughes Aircraft, Space Technology La-

bors, Airborne Instruments Laboratory, General Electric, General Precision, Bendix Aerospace, Radio Corp. of America and General Dynamics. Apparently, funds allocated for this program were reprogrammed elsewhere and program objectives are now being reevaluated to allow it to coincide with money from another project.

- Rendezvous Sensors**—Proposals for a 14-month research and development effort covering the ground of infrared, RF and optical techniques were requested by Aerospace Systems Division this spring (AW Apr. 23, p. 99). Requests were received and received recently. Industry proposals are now due late this month.

The current and anticipated difficulties associated with sensor requirements for rendezvous vary markedly depending on whether the rendezvous is cooperative, in which case the chase and target vehicles jointly try to effect rendezvous, or non-cooperative. In the latter case, the target vehicle may not admit and its noncooperation, but way of attempt to evade rendezvous and just or combat chase vehicle sensors. If one or both vehicles are unarmed, the complexity of the sensor problem changes again.

Reliability and high performance, particularly long-term stability and close accuracies through periods of unattended operation are expected to be top considerations in selecting electronic sensor systems for rendezvous missions. Perhaps several demands for small size, light weight and low-power requirements also will be important but not necessarily primary objectives, at least in the anticipated large size manned military space vehicles.

### Friendly Rendezvous

If rendezvous is friendly, radio frequency beacons or transponders can be carried on target vehicles, thereby lowering RF power requirements (lower the size, weight and complexity of the RF equipment on the chase vehicle, or boosting system performance or a one station of chase). A target vehicle also can transmit positive, but be cooperative by being fitted with a cluster of corner reflectors. Search, detection and identification and tracking facilities may all be more simple in the cooperative than in the non-cooperative case.

Typical types of tracking data as required for guidance and control in a cooperative system that may be utilized directly or derived from several data sources, as indicated in Hughes Aircraft radar sensor studies, include:

- **Range data** from a maximum of 150 mi. to distance and doubling with 1% desired accuracy, 2 to 1% in double with well over halfway possible in the closing phase. Military requirements may require tighter accuracy.
- **Range rate** from a maximum of 400

### Sensor Combinations Requiring Development For Cooperative Rendezvous

Combination	Terminal Angle Range	Docking Angle Range	Est. Availability
Pulsed radar—IR angle tracker (note.)	X X	X	1962-1963
Standalone range (note.)		X	
Range only radar—IR angle tracker (note.)	X X	X	1962-1963
Standalone range (note.)		X	
IR angle tracker (note.)	X X	X	1962-1965
Optical intensity ranging		X	
Standalone range (note.)		X	1966-1968
IR angle tracker (note.)	X X	X	
Optical intensity ranging (note.)	X	X	1966-1968
Range-only radar tracker (note.)—(IR for angle & optical radar for range)	X X X	X	
Standalone range (note.)		X	

### Sensors Available For Cooperative Rendezvous

Combination	Terminal Angle Range	Docking Angle Range
Pulsed radar—Visible optical techniques	X X	X X
Pulsed radar—IR angle tracker—automatic	X X	X X
Standalone range—manual		X
Range only radar—IR angle tracker—automatic	X X	X X
Visible—manual		X X
Range only radar—IR angle tracker—automatic	X X	X X
Standalone range—manual		X X
Pulsed radar—Television—manual	X X	X X
Range only radar—IR angle tracker—automatic	X X	X X
Television—manual		X X

**SENSOR COMBINATIONS** indicated at top can become available at time indicated for rendezvous missions where target vehicles have beacons. Bottom chart shows an sensor combination available for cooperative rendezvous with beacons-equipped targets.

to, down to 1 ft. per second and 1 ft. per second. For most accuracies at the same rate will be required. In non-cooperative situations (besides from the need to impact and possibly destroy when space vehicles, to clear space debris and to rendezvous with a friendly vehicle that

For effective rendezvous, a mix of sensors, not highly sophisticated, probably will be required. In non-cooperative situations (besides from the need to impact and possibly destroy when space vehicles, to clear space debris and to rendezvous with a friendly vehicle that



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is available to the user in real time, the user as well as sensor redundancy becomes especially important. Where the target uses electro-optical countermeasures against the chase vehicle, devices and techniques can be inserted. The chase vehicle may also need passive techniques to sense radar or RF radiation from the non-cooperative target.

In reviewing sensor requirements for cooperative radars, Hughes prefers, among other types of RF sensors, or passive, non-coherent pulsed radar with a transponder for terminal guidance to obtain range, range rate, angles and angle rates down to the final 100 ft from docking. In preference not shared, maneuvering is sensed through shadow (maneuvers). The radar might be supplemented by an optical device for the last 100 ft.

FM/CW radar, Hughes points out, is normally limited to measure range capabilities and the Doppler, maintains, a of questionable value at short ranges near docking close, although less so than a pulsed radar system. In general, Hughes regards RF sensors as being suitable for terminal guidance, but limited in measuring range performance and insensitive for docking.

Infrared optical sensors, Hughes engineers point out, are well adapted to angle tracking at ranges where available signal levels are available. A cooperative infrared source stepped in situations can be employed effectively at intermediate ranges. Angle and angle rates are available at higher accuracy and with higher response than measures for RF sensor. In addition, in cooperative systems where a beacon is employed on the target for more accurate tracking, its sensor intensity can be stepped down as the range decreases thereby keeping a useful sensor intensity even at docking range.

The principal shortcoming of an optical sensor, difficulty in obtaining range, can have several solutions. A calibrated laser on the target vehicle and a separately calibrated receiver on the chase can permit accurate ranging to actual distances (Hughes says). In situ range measurement would provide range rate.

Optical sensor radar techniques (AW Feb 27, 1961 p. 61) under intensive development at Hughes and elsewhere offer the possibility of providing highly calibrated range-rate and range rate measurements at longer ranges and perhaps with resolution superior to that of RF sensors. With passive infrared angle tracking enhanced optical radar offers an eventual possibility of achieving a single integrated optical system. Such a resolution sensor system, Hughes estimates might be available between 1965 and 1968.

For docking, manual visible devices and television optical devices could



**CLOSE-UP OF STL RADAR/TRANSPONDER** radonson system shows radar components which STL says can be packaged into system weighing 45 lb., not including antenna

offer intermediate cooperative capabilities.

Both optical and RF techniques and combinations of them are under study for non-cooperative systems. An RF approach to the would involve a non-coherent pulsed system from a maximum range of 50 m down to 100 ft, and an FM/CW system from that point, according to Hughes. A system of that type could be operational in 1964. An optical approach to non-cooperative radars, Hughes suggests a combined infrared optical radar system in which IR will handle target acquisition and angle tracking and the optical radar would supply range data. At ranges shorter than 500 ft, an FM CW radar would again be necessary.

## Optical Detection

Because of large possible power usage, passive optical detection is advantageous for search and acquisition of covert targets to save the power that otherwise would be necessary in actively searching large volumes of space.

Passive devices could sense energy emitted by an object from numerous capture targets. Sources of this energy, which include thermal emission from the target, thermal emission from the skin of the vehicle and perhaps radiation from vehicle radars in the event but give attitude control and maneuvering radars are employed for evasion maneuvers.

Under certain conditions, reflected solar radiation can offer an advantageous technique for detecting solid vehicles because it can be used against them thermal emission and radar possible

the use of detectors, like image analysis and photomultipliers, which are more sensitive at shorter wavelengths (infrared and ultraviolet) than at infrared. Thermal radiation is a more reliable source of radiation sensing, however, since the target vehicle can be made to control its inputs, or can be made available if its surface has low reflectivity. In addition, Hughes points out, the detector sensor system would be able to look down, potentially dangerous for target vehicles which would not be the earth's shadow along much of the time.

## Radar Design

Raytheon's Missile and Space Division has been studying radar systems for orbital radars for some time, part of its studies under Marshall Space Flight Center's Orbital Launch Operations program (AW Mar 15, p. 78).

For the cooperative radars, Hughes suggests a sensitive microwave FM/CW radar/transponder which, it says, would require accurate velocity and range data over a clear range and low velocities. At 4000 ft, an accuracy of 0.05 ft/sec is possible by measuring Doppler shifts for a second. Range can be measured by the amount of delay it with a ranging technique of measuring phase of two or three modulating frequencies at a few thousand cycles.

The transponder designed would a single microwave tube plus other available components, a modulator and lighter than a pulsed transponder of the same sensitivity, more reliable than a pulsed receiver-transponder because it can last possibly of greater components

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and old-timer crews working at low peak power levels, the company explains.

Rathbone proposes a K-band radar (11.2 to 14.25 GHz) to suit antenna configurations such that it does not look through any possible reflectance which would tend to produce high electron densities through ionization and cause visible, audible cross-sections and range errors, particularly at higher frequencies. To cover the same errors if a K-band at 40 GHz (400 nm), electron density would have to be three orders of magnitude higher. Electron densities do, in radar beam ionization will ion in order of magnitude as in different portions of the beam, making radar performance dependent on visible configurations lined right to the target, fuel and motor run.

The proposed K-band system, shown in accompanying block diagrams, would use a 1 watt 13.5 kHz microwave oscillator, possibly a substitution oscillator, a ferrite phase shifter driven by modulated frequency of 2 mc, 48 kHz and 480 kHz, respectively, respectively, to various ranges of about 0.64 mi., 1 mi. and 100 mi. Rathbone says, in roughly 1 radian, giving a resolution index of 1 at each modulation frequency.

Frequency-modulated radiation received at the antenna of the transponder on the target vehicle will be mixed with the output of a local oscillator, which is sufficient to cause the resulting carrier frequency to be mixed in a wide bandwidth 11° angle. The 2nd subband is composed of a derivative, modulated up to 24 mc, mixed with the 11 mc signal frequency (containing Doppler shifted carrier and subband) to produce a 54 mc signal. This signal is then mixed with the local oscillator output resulting in a carrier frequency 24 mc (not counting the Doppler shift) higher than the frequency received by the transponder.

The additional 24 mc represents a signal received from the radar (even though it was derived from an oscillator) and it is possible to radiate transponder output frequency. Class of 120 db is possible through the transponder with a constant antenna noise level. Rathbone says.

Signals returned to the radar by the transponder are mixed with CW noise, which causes, producing a 24 mc IF.

The microwave Doppler shift is approximately 20 to, as for lead signal to waste time for accurate data processing, the pre-detector bandwidth is kept below 10 Hz. A frequency tracking unit is added.

The tracker with a variable frequency oscillator and feed multiple response units tracks the subband to obtain good signal to noise ratio. The output

of the carrier filter is heterodyned with the 24-mc reference frequency to produce a Doppler frequency measured by counting cycles and given peak-to-peak velocity to an accuracy of about 0.05 ft/sec for a conventional measuring time.

Modulation subband plus carrier are sent to the discriminator, mixing frequency subband, an antenna and phase compared with original modulation frequency.

## System Reliability

To ensure system reliability for a computer system, in which the microwave tube in the transponder has the thinnest lifetime among active components, Rathbone recommended non-redundant parts, solid-state Doppler and FM CW tubes of the same frequency, total antenna aperture and receiver noise figure to determine whether the transponder could be elevated. For this case, it again utilized FM CW as an optimum system because of the paucity of low-noise tubes, ground range and range rate capability and relative size, weight and power advantages.

Survival of the transponder requires a substantial excess in noise sensitivity to make the system feasible even at ranges of about 10 mi. System sensitivity is most effectively supported with a noise scheme closer to the target to clear a range of a volume of a 2 ft diameter sphere offers 49 sq meters volume area that bounding sensitivity is 16 db. This may also solve problem of ghost effect at short ranges.

Other methods of improving system sensitivity, a number of which were explored, include a small amount of transmitter power at the rate of a low-noise parametric amplifier in lower receiver noise figure and the use of multiple filter acquisition channel to reduce active power requirements.

At short ranges, gain rate cause problems gain accuracy at larger ranges may be the result because of low signal to noise ratio. Consequently, Rathbone recommends a transponder on the corner reflector, negating the possibility of using a combination with the reflector as a backup of the radar case used with or without a transponder.

The radar/transponder system (with out beam reflector) would weigh 145 lb—the transponder 45, and the radar 36.

Radar would consume 32 watts, transmit 4 watt, have a maximum before failure (MTBF) of 2,200 hr, an antenna gain of 27 db (due to 5-in. dish) and a signal to noise ratio of 160 as of 10 db per antenna bandwidth. Transponder would have an output power of 0.1 watt, consume 30 watts, and have MTBF of 2,600 hr.

Radiation radar designed for the

combination, transponder or corner reflector system weighs 14 lb, requires 140 watts, presents 7 watts, has a MTBF of 2,000 hr, and maximum antenna noise figure of 7.5 db.

For the non-cooperative situation, Rathbone estimates that a 11 db receiver performance will be necessary for the radar designed with dual transponder-corne reflector capabilities. This assumes the target has an echoing area of 2 sq meters.

The required performance may be obtained by substituting a parametric amplifier in the receiver for a 41 db improvement in receiver sensitivity, an amplifier in place of the 5-volt diodes for a sufficient increase in tube efficiency to reduce transmitter power by 41 db.

If the lifetime is followed by an amplifier, according to Rathbone, both can be used for a short time during acquisition and early tracking phases. An end-of-range vehicle approach and another, the amplifier supply can be switched off and radar operated at low power during longer tracking or station keeping phase. This would save power and simplify cooling and reducing the source range problems the computer.

## Equipment Available

Among specific manufacturers, radar equipment is being available, the following:

• Space Technology Laboratories—An X-band solid state radar transponder system developed by Space Technology Laboratories, Inc., recently was tested on a 47,000 ft range between Redondo Beach and Palos Verdes, Calif., by Space Technology Laboratories. The radar measured range with a 120 ft error in case 18 times what it might otherwise be because of multipath. The radar transmits energy, generated by solid-state transistors, rather than an oscillating tube, at 9.750 mc, its frequency response at 100 MHz.

The radar-corne signal is generated by a 40 mc crystal controlled oscillator, then modulated to 145 mc, where it is transmitter power. If that power is transmitted through a parametric amplifier, based on a diode which acts as a harmonic generator, in this instance the carrier signal is multiplied up to X-band.

Peak 327 power output is 50 milliwatts (about 6 watts are available at input in the multipath) a figure that may be guided to 1 watt at X-band, or 15 watts at K-band, assuming constant use of sub-band components as of 10 db per antenna bandwidth. Transponder would have an output power of 0.1 watt, consume 30 watts, and have MTBF of 2,600 hr.

As an X-band beacon tracker, complete interference-free configurations, the



## AIRCRAFT MANUFACTURERS

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There's good reason why more and more manufacturers of aircraft engines, accessory drives, hydraulic systems and propellers are using Lisle Magnetics Chip Detectors.

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**MODULE OF PULSED RADAR SYSTEM** developed by Emerson Electric Mfg. Co. for cooperative radars shown, left to right: acquisition, transmission post RF amplifier and radar local oscillator. System has antennas range of 410 naut. mi.

radar is expected to make coarse range measurement to  $\pm 0.045$ ,  $\pm 10$  meters and fine range (below 10 kilometers) to  $\pm 0.015$ ,  $\pm 1.6$  meters. Its data can Equation, STL sets, it will range to 1,500 kilometers, measure during velocity to 800 meters/sec. with an accuracy of  $\pm 0.06$  meters/sec. Angular coverage at 1,500 km. is  $\pm 5$  deg. at 700 km.  $\pm 15$  deg. with angle tracking accuracy of  $\pm 4$  millirad or better and angular rate accuracy of  $\pm 0.1$  millirad/sec. or better. MTBF for the radar, according to the company, is in excess of 1,000 hr. (based on parts count, not including failure rates, a space diagnostic test factor and operating time in space).

The radar employs a phase shifter antenna using an improved technique not yet technique developed by STL to supply range accuracy and calibration stability necessary for space guidance. Receiver sensitivity is  $\pm 15$  dB.

The system deliberately has not been optimized for maximum size and weight, but was designed with sufficient intradad flexibility to meet a number of mission or predicting requirements. STL, estimates, that the radar with its cabling will weigh about 40 lb., its system another 10 lb., the transponder and its antenna about 50 lb.

STL also has completed conceptual design of a data handling radar using techniques similar to those employed in its cooperative system.

The cooperative system is designed to be compatible with any type of angle tracking.

• **Emerson Electric Mfg. Co.**—An integrated radar and target transponder system suitable for maneuver between a manned satellite and an unmanned target vehicle has been proposed and is

available from Emerson Electric Mfg. Co. The system employs a modified version of the company's low control MED-7 radar, being manufactured for the General Dynamics B-58 and the Boeing B-52H.

This radar will provide steady, accurate target acquisition and track capabilities to a maximum range of 410 naut. mi. It can supply continuous automatic range and angle tracking to maximum ranges of less than 100 ft. Provisions are made for the display of range and range rate, or their parameters and angle rate are available as analog outputs.

Operating at 8,100 mc, the system will perform a target search at 50 to 1 km and its transponder will respond at 10.51 km. The radar angle including antenna and antenna with reflections expected from further modifications is expected to be 60 lb., another 40 lb. for the transponder. Volume of the radar is 1,250 cu. in., 1,150 lbs. for the transponder, not including the antenna.

General features of the system include 16 watts max average RF power (the search), 0.6 watt for track, 200 pulses per sec. (pps) pulse repetition rate for track, one 500 pps for search, 40 to 10 deg. search coverage, 1 kilometers peak RF power, 2 m. radar acquisition time, 15 deg. sec. angle tracking rate, 1,000 naut. mi. range tracking rate with 1 m. system accuracy.

The Emerson radarsome radar system comprises a manned vehicle subsystem—a steerable antenna with receiver, a receiver-transmitter-zero unit and a control display unit. The receiver receiver package of the radar antenna is the same as the transponder antenna, along with a fixed antenna, by the target vehicle.

The transmitter-receiver package,

shown in accompanying photograph, is cylindrical in shape. The transmitter consists of a two-stage modulator using a hydrogen thyratron, a high-voltage power supply and a magnetron which generates the 2 kilowatt RF signal. A search radar module the magnetron from the effects of varying load and pulsations. The receiver employs a lithium local oscillator, short duration dual-tuned coupler and a low noise input circuit for the RF processor.

A tracking control servo which generates return search patterns and positions the antenna and controls for extending range and angle tracking capabilities from received signals are also housed in the same package.

• **Adhesive Instruments Laboratories**—A lightweight, pulsed radar/transponder system that can supply range information from 1,000 mi. down to 100 ft. with an accuracy of 0.05 to  $\pm 1$  ft., range rate from 1 ft./sec. to 2,000 ft./sec. with 0.15 to  $\pm 1$  ft./sec. accuracy, plus angle and altitude data has been proposed as one technique for use in rendezvousing with the Apollo lunar landing module by Adhesive Instruments Laboratories.

The K, based system can cover 60 deg. angle of vision with  $\pm$  one mil accuracy, supply angle rate information to 154 deg. sec. with an accuracy of 0.1 mil/sec. The radar itself, including antenna will weigh 25 lb., while the beacon will weigh 5 lb. Power consumption will be 30 watts for low pulse repetition frequencies, 35 for high. Antenna will be 30-in. parabolic reflector with a gain in excess of 40 db and a 3 db beamwidth of 0.5 deg. Other characteristics include low pulse repetition frequency (ppf) pulse widths of one microsec., high peak pulse widths of 0.1 microsec., ppr. rate variable from up to 1,100 pps., power level of 2 kilowatts,  $\sim 45$  dba (average decibel) signal for 1-m. video bandwidth.

• **Westinghouse Electric-Air**—A low-powered radar/transponder capable of measuring range to an accuracy of one foot out at ranges of 60 mi. and  $\pm 20$  ft. at short distances is being developed by Westinghouse Air Arm Division, Baltimore, Md. The system is designed to give both automated and operator chosen vehicle acquisition, tracking and guidance information. The system is said to be capable of acquiring a target and tracking it in range and range rate over a 90 deg. solid angle.

Series of one microsecond interrupting pulses at a frequency of 250 pps trigger the transponder on the satellite and its own microsecond signal, offset from radio transmitter frequency, as picked up at the close. The leading edge of the pulse is used for measuring range (range rate by differentiation), the remainder for azimuth, then elevation angle. Angle measurement is made by interferometry techniques.

## Space Vehicle Log

(As of June 5, 1962)

Satellite in Orbit <sup>1</sup>	Name	Launch	Period (Min.)	Apogee (Stat. Mi.)	Perigee (Stat. Mi.)	Transmitting Freq. (Mc)	Weight in Orbit (Lb.)
1958 Alpha 1	Explorer 1	1 Feb. 16	102.6	1,240	320		30.6
1958 Beta 2	Vanguard 1	17 Mar. 16	103.0	1,440	465	104.00	36.3
1958 Alpha 3	Vanguard 2	17 Apr. 20	103.2	1,372	327		31.5
1958 Beta 1	Vanguard 3	18 Sep. 12	103.1	1,250	320		32.41
1958 Alpha 1 (2500)	Junos 1	2 Aug. 20	430 Pps	1,000	500	1.000/100	15.4
1958 Beta 1	Fluores 4	2 Mar. 20	300 Days	1,000/100	0.001/100		81.0
1958 Beta 1	Explorer 7	10 Oct. 20	101.1	470	340		34.8
1958 Alpha 1	Fluores 2	11 Mar. 20	311.4 Days	0.001/100	0.001/100		14.8
1958 Beta 2	Trans 1	1 Apr. 20	79.1	460	410	107.997	37.0
1958 Beta 2	Trans 1B	11 Apr. 20	78.3	387	322		36.6
1958 Beta 2 (2000)	Spinks 4	13 May 20	70.0	300	322		10,000
1958 Beta 1	Altos 2	24 May 20	94.7	214	302		3,000
1958 Beta 1	Donat 2B	23 June 20	101.6	410	320	105.014	35.0
1958 Beta 2	Bliss	25 June 20	101.6	410	320		32.0
1958 Beta 1	John 1	10 Aug. 20	110.7	1,000	460		44.0
1958 Beta 1	Geosync 1B	4 Oct. 20	146.0	700	615	107.999	42.0
1958 Beta 1	Explorer 8	2 Dec. 20	112.4	1,000	340		36.14
1958 Beta 1	Trans 3	18 Mar. 20	79.0	410	320		36.0
1958 Alpha 1	Trans 3	31 Jan. 21	14.9	330	260		4,300
1958 Beta 1 (2000)	Venus Probe	15 Feb. 21	586 Days	1,010/100	0.7/100		1,419
1958 Beta 1	Explorer 9	14 Apr. 21	117.0	1,000	420		36
1958 Beta 1	Shuttlecraft 20	17 Feb. 21	50.0	300	137		0.400
1958 Beta 1	Explorer 10	15 Mar. 21		Position Unknown			38
1958 Beta 1	Explorer 11	27 Apr. 21	107.6	1,200	302		43
1958 Beta 1	Trans 1A	28 Apr. 21	103.0	684	345	104.150, 104.480	17.6
1958 Beta 1	Explorer 12	29 Apr. 21	102.0	524	340	130.2	6.5
1958 Beta 1	Trans 2	12 July 21	100.0	600	465		36.0
1958 Beta 1	Altos 3	13 July 21	140.1	1,100	210		3,000
1958 Beta 1	Explorer 13	14 Aug. 21		Position Unknown			43
1958 Alpha Beta 1	Altos 4	15 Oct. 21	100.4	1,100	350		3,500
1958 Alpha Beta 1	Copernicus	10 Oct. 21	100.4	1,200	320		3,000
1958 Alpha Explorer 1	Discoverer 24	5 Nov. 21	94.4	400	340		3,100
1958 Alpha Beta 1	Trans 4	12 Nov. 21	102.0	400	313	110.0, 104.220, 105.400	100
1958 Alpha Beta 1	Trans 5	10 Nov. 21	101.4	400	300	110.0, 104.220, 105.400	100
1958 Alpha Beta 1	Trans 6	22 Dec. 21	111.1	320	245		370
1958 Alpha 1	Ranger 2	24 Jan. 22	486.4 Days	1,010/100	0.7/100		2,000
1958 Beta 1	Trans 7	7 Feb. 22	100.2	322	263	110.25, 110.35	100
1958 Beta 1	OSO 1	7 Mar. 22	81.0	340	263		44.0
1958 Beta 1	Trans 8	9 Mar. 22	101.2	314	140		140
1958 Beta 1 (2000)	Explorer 12	6 Apr. 22	101.2	410	310		1,700
1958 Beta 1	Explorer 13	24 Apr. 22	91.4	100	100		100
1958 Beta 1 (2000)	Altos 5	24 Apr. 22	100.0	740	300	110.400	120
1958 Beta 1	Trans 9	13 May 22	111.0	310	130		130
1958 Beta 1	Trans 10	28 May 22	100.0	300	120	90.004	
1958 Beta 1	Trans 11	29 May 22	80.7	110	120		120
1958 Beta 1	Trans 12	2 June 22	80.0	340	121		121
1958 Beta 1	Trans 13	2 June 22	80.0	340	121		121

<sup>1</sup> Orbital elements of radar satellites given in Astronomical Units, approximately 93 million mi. \*Frequencies given only for satellites orbiting Earth. <sup>2</sup> Military satellite carrier vehicle, which was made effective in late 1961, probably received designation as characteristic of military space vehicle launch. Satellites in this category are Discoverer, Altos or Fermi. Designations have not received German weights. <sup>3</sup> B. has launched all satellites except those noted (OSO). And payload was sent to G. United Kingdom development. Previous log was published Mar. 10, p. 147.

Source: National Aeronautics and Space Administration Operations Control Center, North American Air Defense Command (NORAD), and Smithsonian Astrophysical Observatory (SAO).



**THREE-SERVICE TWIN-ENGINE V/STOL TRANSPORT**, being built by Ryan jointly with Puugh and Ruloff. Designed to transport troops, cargo and weapons, the V18-40 will be produced to meet Army, Navy and Air Force logistical requirements.



**RYAN X-29 VERTUEX**, world's first jet V/STOL aircraft, was developed under Air Force and Navy contracts ending back in 2004. This was last aircraft to demonstrate the feasibility of vertical jet take-off with transition to level flight.



**RYAN X-29 VERTUEX**, a research aircraft designed, built and flown by Ryan for the U.S. Army and Office of Naval Research. It uses prop-jet engines and a lightweight deflected by large wing flaps to achieve STOL take-off and landing.

## How to get maximum performance from V/STOL aircraft?

The Ryan V/STOL engineering team has the answer. With three million engineering manhours devoted to four vertical take-off research projects, Ryan is the world's most experienced and knowledgeable specialist in high speed V/STOL aircraft.

Newest and most advanced of these projects is the U.S. Army's VZ-33 research aircraft now being designed and built by Ryan. Powered by General Electric's lift-fan propulsion system, it will be capable of vertical take-off, yet cruise in normal flight at more than 500 mph. The VZ-33 concept provides maximum jet thrust augmentation for take-off (engine thrust is multiplied 3 to 7 for vertical flight).

In many space age areas, flexible, fast-moving Ryan is making significant contributions. Ryan is the world's largest designer and producer of Doppler navigation systems and jet target drones. Among other Ryan activities are Flex Wing applications, electronics systems for lunar landings, and structures for space vehicles.

All Ryan Aerospace and Ryan Electronics, technical and management capabilities are designed to assure compliance with the most stringent standards.

RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIFORNIA

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## BUSINESS FLYING



BEECH MODEL 33 MUSKETEER shows typical company design lines. Four-place aircraft cruises at 155 mph at 7,000 ft on 75% power.

### Aviation Week Pilot Report:

## Musketeer Blends Simplicity, Versatility

By William S. Reed

Wichita, Kan.—Frequent flights in the Musketeer, Beech Aircraft Corp.'s four-seater, for a share of the low price, four-place lightplane market dominated by the Piper Cherokee and Cessna 172, indicate the aircraft is easy to handle with performance and range enough for a wide variety of business, training and pleasure flying uses.

Principal features of the Model 33 Musketeer, which Beech will release to dealers next fall are:

- **Large, roomy cabin** 7.61 ft long by 3.1 ft wide. The Musketeer has an interior 19.5 cu. ft. of baggage space aft of the rear seat with no external access door.
- **Agile, fuel-injected landing gear** with rubber duck shock absorbers and individual hydraulic brakes. Total of the main gear is 11.66 ft and wheel base is 6.5 ft.
- **Cruise speed** of 115 mph at 7,000 ft using 75% power. At full power setting, the Musketeer has a range with reserves of 885 mi.
- **Price tag** of \$11,360 (including all optional instrumentation, a complete radio installation and night lighting equipment) (AWM Mar. 28, p. 117).

The Musketeer represents a departure in Beech thinking in more than one respect. Designed from the start as a five-year aircraft, the engineering effort has been aimed at producibility without

sacrificing safety, durability or appearance. Project Engineer John I. Elton says that the Musketeer parts list includes only 1,000 items compared with over 1,000 for the Bonanza. Beech also has pioneered the use of light planes of bonded aluminum honeycomb construction as the wing placed forward of the main spar (AWM Dec. 4 1981, p. 94) which results in an ultralight aircraft 50 lb lighter than conventional construction.

Other more noticeable include a tricycle landing gear, the three main sections of which are aligned. Not only are the wheels interchangeable but so are the struts, landing and shock absorbers. The complete engine assembly plus firewall and including the nose gear assembly is removable in disconnecting the bolts and the plumbing and electrical connections. Advantage here is ease access to the control system, fuel, instruments, etc., during major maintenance.

Beech also has had to "do-capacity" the Musketeer in more respects, according to Musketeer Sales Manager Mike Gordon. Traditions throughout the plant was and still is to compare the new four-year Model 33 with the larger four-cylinder Beech products. Thus when pilots compared the new airplane with its predecessor, the Musketeer did not seem as strong on miles some inherent assumptions and in details which meant production tech-

The extra work force had to be re-motivated continually that the Model 33 is a low-cost aircraft and at such approach a more modern approach than is used with the company.

Even so, the Musketeer is pleasant to fly and while it may be slower and less luxurious than other Beech products, it stacks up well in comparison with contemporary aircraft in the same price range.

The Musketeer sits low to the ground but not so low that operation in reasonably rough terrain would be prohibited. Twelve tie-up clevises in 14 in. enough for taking fairly large ground irregularities in stride.

Entrance to the cabin, both front and rear seats, is gained through a large door on the right side of the fuselage. A walk-around inspection of the Musketeer reveals the unusually smooth-to-light aircraft-like of the wing. The wing is twisted 2 deg-1 deg of wash-in at the root decreasing to 1 deg at the tip—so that tail will begin at the root and streamlines centered at post-stall airports. Wing tips are designed for easy replacement and are made from molded glass that with built-in wing tips.

Empennage consists of a swept fin and rudder and a low mounted stabilizer (one piece construction stabilizer elevated with a transverse actuator) with a transverse actuator. Principal advantage of the over-engineered stabilizer is



WIDE TRAIL of Musketeer is evident in photo of landing at Beech Airport, Wichita, Kan. Flying above the Musketeer is a Model 33. Musketeer's wide-open flap is usually operated with two positions—15 and 30 deg. Musketeer touches down at 65 mph with flaps. Range system incorporated in Musketeer can be extensive, with changing altitudes from control altitudes such as 7,000 ft. Musketeer is a standard but is not standard. Light being kept in sight.

that a smaller area is required with a corresponding saving in weight and drag. Stabilizer trim also is of glass fiber.

Instrument panel of the Musketeer is large and accommodates engine and flight instruments in front of the pilot with radio gear in the center. All instruments except gross and surface gauges are included in the base price. Also included in the VHF air/comm radio including microphone and cabin speaker. The radio includes:

- **Separately tunable 90-channel crystal-controlled transceiver** (115.0 to 116.9 mc.) with a transmitter output of 5 watts.
- **Separately tunable 160 channel crystal-controlled comm/traffic receiver** (116.8 to 117.9 mc.).
- **Double main-busbar connection and indicator.**

Master switch for the 160 hp Lycoming O320-B engine is combined in the key-operated ignition in automobile fashion.

Tuning is accomplished with differential braking through non-operated hydraulic brakes. The nose wheel, although steerable, is not variable. The Musketeer can easily be nose-over on the ground even through sharp turns because of the turning moment imposed by differentially braking the main wheels. On straight, long stretches of runway, the rudder will exert steering force even at low speed making repeated brake applications unnecessary.

Takeoffs on the flight made by Armstrong White were to the north. Direction of Beech Airport is 1,371 ft

The temperature was 51°F. With fuel load at a maximum of 50 gal and Beech Test Pilot Vaughn D. Grogg and then Armstrong White pilot about the gross weight of the Musketeer was 7,090 lb. Another 150 lb. of extra cargo or passengers could have been carried to bring the total to 7,240 lb. for normal gross weight.

Lack of nosewheel steering caused some apprehension that perhaps a little braking action might be needed during the takeoff roll but the model acting in the propeller alignment was effective enough to keep the aircraft aligned with

the runway even at the outset. Some moderate brake tapping might be necessary in a strong crosswind. It is the case with most nosewheel aircraft not having nosewheel steering. Crosswind takeoffs would appear to be not unusually difficult, however.

Back pressure on the wheel when the airspeed showed about 60 mph began motion and the Musketeer flew off the ground at 65 to 70 mph. Takeoff run was about 450 ft. The aircraft was allowed to accelerate to a best climb speed of 55 mph, at which time the rate of climb indicated 750 fpm. Over



PROTOTYPIC AIRCRAFT instrument panel clearly illustrating that possible on Musketeer production model, shows all flight and engine instruments grouped in front of pilot.

## NEW— MATHEMATICS MANUAL

When you solve all kinds of problems in arithmetic, algebra and geometry, you'll find a tremendous field of application in many other fields, including electronics, or safety mathematics for building better cars, ships, airplanes, and missiles.

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**MISSISSIPPI PRODUCTION LINE** photo shows one of installing engine controls and instruments through use of detachable nose assembly.

the nose assembly is very good even in a climb but engine windows in the roof over the engine windows would be a definite aid in scanning for other traffic.

Neither rudder fence nor position needed to trim out for climb was excessive. Elevator lever gradient proved to be somewhat steeper than expected but not unacceptable, and having a high pitch or pull force on the control wheel when flying out of the trim condition causes the aircraft to return to the trim position faster than a shallow gradient does. A baggage system carrier's rudder and aileron and on flight the airplane can be turned by movement of the

rudder alone or by turning the control wheel. For deliberate cross control maneuvers such as unusual loadings, the baggage system is easily overpowered.

A convenient feature in the aircraft is the throttle lock, which is operated by turning the knob through about 45 deg. To change throttle position, it is necessary only to twist the knob to the left, slide the nose setting and press to the right to lock it securely. The lock, actuated against the fuel control, is most effective yet convenient by this pilot.

Crane figures published in flight as given to be on the conservative side

### Beech 23 Musketeer Performance Data

Maximum speed at sea level, full throttle (2,700 rpm) 144 mph	
Cruise speed, 75% power at 7,000 ft 135 mph	
60% power at 10,000 ft 125 mph	
55% power at 10,000 ft 121 mph	
50% power at 10,000 ft 117 mph	
45% power at 10,000 ft 113 mph	
40% power at 10,000 ft 109 mph	
35% power at 10,000 ft 105 mph	
30% power at 10,000 ft 101 mph	
25% power at 10,000 ft 97 mph	
20% power at 10,000 ft 93 mph	
15% power at 10,000 ft 89 mph	
10% power at 10,000 ft 85 mph	
5% power at 10,000 ft 81 mph	
0% power at 10,000 ft 77 mph	
Rate of climb (sea level, max gross) 730 fpm	
Initial climb, 50 ft altitude 1,100 fpm	
(sea level, standard day) 1,100 fpm	
Landing distance, 50 ft, obstacle 1,100 ft	
(sea level, standard day) 1,100 ft	
Service ceiling 15,000 ft	
Absolute ceiling 15,000 ft	
Gross weight (fully equipped) 3,600 lb	
Gross weight (empty) 2,800 lb	
Empty weight (with standard equipment) 2,800 lb	
Empty weight (with standard equipment) 2,800 lb	



## HE'S REDUCING THE COST OF AN ENGINE OVERHAUL

It is customary for overhaul shops to use a vapor blast to clean the baked-on carbon from turbine engine blades and discs. This is a slow process. The material to be removed resembles a very tough varnish. Every bit must be removed from the surface of the metal so any cracks present will be easily visible. But slurry covers up the work, the operator works blind, the danger of eroding the metal beyond maximum limits is great.

Airwork looked for a better way—and found it. In the dry hater used in an offed industry. This proved to be not only faster—but gave the operator a constant, un-

obstructed view of the work. The result: less chance of metal erosion—and a better inspectable surface that makes metal flows easier to spot.

This is one result of our constant effort to reduce costs while increasing reliability. It saves many labor dollars as a Dart engine overhaul... and will soon be saving money on piston engine overhauls, too.

There are over 55 Airwork dealers East of the Mississippi who sell and service Airwork overhauled engines. This organization, the largest of its kind, includes every major fixed base operator in the East... one more good reason to buy and fly Airwork.



**ESSENTIAL AVIATION  
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## ARMY IROQUOIS CLAIMS THREE MORE RECORDS

**TIME TO CLIMB** 6,000 meters (19,686 feet)  
in 5 minutes, 51 seconds

**TIME TO CLIMB** 3,000 meters (9,843 feet)  
in 2 minutes, 14.6 seconds

**SPEED RUN** 1,000 kilometers (621.4 miles)  
with top speed of 150 mph... average  
134.9 mph

Further climb, higher speed, greater range... demonstrate the Iroquois' outstanding performance capability at all tactical altitudes. With these three new records, Bell now holds 10 claims 93% of all helicopter records held by U.S. manufacturers... 34% of all world helicopter records. Bell contends the Army Aviation Board plans for establishing these marks. The Iroquois used was a 13-place YHU-1D helicopter, powered by a 1,100 hp Lycoming T-53-L-9 gas-turbine engine in the speed run, using a standard auxiliary fuel tank. The YHU-1D demonstrated its ferry range which exceeds 700 miles. Other services can get more helicopter performance for their dollars, too, with the YHU-1. It has the inherent flexibility to meet today's mission requirements, and is now being phased into production ready for off-the-shelf procurement.

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since they were only topped during flight. For example, French figures show a true ascent of 135 mph at 7,000 ft, pulling 2,600 rpm at 7,500 feet. The new record was achieved by the Iroquois flown by Alexander Weiss, N13353, showed a true ascent of 140 mph. Gross weight was less than maximum for the test as temperature at 7,500 ft was 14°C, above 13°C above standard. As to apparently the exact performance figures, if in error at all, in on the conservative side. Fuel consumption at the above power setting was 9 gph, which would have yielded a range in excess of 300 mi with reserve. Other speed power data taken on the flight at 7,000 ft showed that at full throttle—2,700 rpm—the true ascent was 145 mph. At 2,700 rpm, true speed was 175 mph and 2,400 rpm brought 130 mph. WAS

**Stall Procedures**  
Stalls in the Model 29 are straightforward and require the application of no unusual techniques.

With a forward center of gravity, that is without progenies in the rear seat, the Modeler cannot be thrown out at an upward loss this 50 mph, and that results in a considerable pull force being required during power-off stalls even with full nose-up trim. Therefore, it is a safety feature that the trim is limited to an upward above that of when the engine stalls. Also, there is barely enough elevator power to produce a stall. The Modeler will stall power-off with full back elevator but the nose immediately drops forward and brings

speed is regained. If the wheel is held full left, a series of very mild stalls results, throughout which ailerons and rudders control are retained. Power-on stalls are similarly mild. Again, it is not possible to have the aircraft trimmed to that a sudden application of power will result in a too sudden pitch-up attitude with the possibility of an inadvertent stall. Ailerons and rudders control are retained at post-stall attitudes with power on as with power off. Additionally, the air brake required to produce a power-on stall is very strong, leading again to the conclusion that an inadvertent power-on stall would be unlikely.

In addition to normal stall warning from aerodynamic buffet, the Modeler is equipped with a stall warning indicator which sounds a horn approximately 5 mph above actual stall. Thus, power-on, the stall actually occurs at 60 mph with the horn sounding at 65 mph. Power-off, the Modeler stalls at 65 mph, flaps up and at 65 mph with 10 deg. of flap.

Leading the Modeler require nothing in the way of extraordinary skill. The pattern can be flown at 100 to 120 mph and the aircraft handles easily at these speeds. Flaps are lowered below 110 mph by a handle located on the floor between the front seats. Two positions, identified by the locking of a

flap-operated button atop the lever, are available: 15 deg and 30 deg.

Final approach is flown at 40 to 45 mph, depending on the load carried and the wind condition. Visibility throughout the pattern is good and control about all there is to stall. The deliberately designed fairly steep climb to final glidepath caused a slight over-control on the first attempted landing but this was easily compensated for in subsequent landings. The wide gear track adds to the simplicity of landing and permits touchdown in a variety of more difficult terrain to pilot, passenger or equipment.

All in all, the Bell Modeler is a far from unusual flying machine, and desirable in all circumstances. It should make an economical business aircraft as well as a handy trainer or sport flying vehicle.

Available as an option for training purposes is a simulated landing gear lever. Mounted in a wheel and located in the center of the instrument panel, the lever can be used to train students for inadvertent retractable gear accidents. A green light glows when the lever is down and a red light illuminates when it is up.

Should the student forget to lower the gear, a warning horn will sound when the throttle is retarded and the aircraft is below 110 mph.

## RICHMONT—THE ONLY COMPLETE TORQUE CONTROL SYSTEM

Now in use in industry, one of the most complete and accurate systems for torque control.

This Complete System Includes:

- Free Torque Headset. Handles ranges from 10 to 200—50 to 250—100 to 750—400 to 1,000.
- Torque Amplifier. Range: 0-1,000 in ft. 0-150 lb-ft.
- Universal Adapter to fit all types and means from 1/8" to 3".
- Full range of Wrist Rests. Interchangeable to fit various handles.
- Self contained in 22 volt engineered carrying case.

The Richmond system is the only universally packaged method of setting, measuring and checking torque to engineering specifications right on the job.



LOOK TO THE LEADER

**RICHMONT PRODUCTS**

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### Musketeer Dimensions

Wing span	145.00 sq ft
Wing loading, gross weight	25.66 lb/sq ft
Power loading, gross weight	14.10 lb/hp
Wing area	52.71 ft
Wing chord	12.71 ft
Flap area	16.7 sq ft
Engine length	23.8 ft
Engine height	5.75 ft
Wheel base	6.5 ft
Wheel track	11.66 ft

### Cabin Dimensions

Length (instrument panel to rear bulkhead)	94 in.
Width (floor)	48 in.
Height (floor to ceiling beam)	46.4 in.
Headroom (seat seat to seat to seat)	79.25 in.
Headroom, rear seat (seat to ceiling)	37.75 in.
Baggage compartment capacity	440 lb.
Baggage compartment volume	29.5 cu ft
Baggage door size	15.5 x 23.75 in.



# INTERNATIONAL AIR TRANSPORTATION ISSUE SEPTEMBER 10, 1962

The impact and challenge of recent trends and developments in international air transportation will be the subject of AVIATION WEEK & SPACE TECHNOLOGY's *International Air Transportation Issue*, September 10, 1962.

This major editorial effort will analyze the direction and problems associated with the growth and expansion of air transportation in all major world markets including Atlantic, Europe, South America, Africa and Asia.

Subjects slated for special emphasis are: Development of a new U.S. international air policy; World-wide impact of common market and African consortiums; New flag carriers of emerging nations; New trends in supersonic transport research; Communist bloc penetration in world air markets; 1962 traffic trends; and future international tariff and merger problems.

Copies of this issue will be airlifted to delegates at the opening session of the International Air Transportation Association (IATA) Conference in Dublin, Ireland. Here will be gathered the international leaders of air transportation whose attention and discussions will be focused on these and other major issues.

With AVIATION WEEK's reputation as the authoritative, respected voice of international aviation, the *International Air Transportation Issue* will receive world-wide readership and impact.



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Grumman Aircraft Engineering Corp.'s 50-ton A-1H hydrofoil reaches 50 kt. with just 5 ft. above water in Long Island Sound.

## Grumman Hydrofoil Reaches 50 kt. in First Test



Ship is 104 ft. long, has complete aluminum construction, runs two General Electric M240 gas turbine engines. Current speed runs 40 kt. and high-speed foil version under development will increase maximum speed to 50 kt. After start foils weigh 15 tons each, are hydraulically actuated, and retract by swinging outward and upward. Propeller is located on gull at bottom of stern foil.



Sixty-passenger vessel, primarily a hydrofoil research ship, also will be used as ferry between Florida and Bahamas.

What is the rightmost digit of  $7^{17}$ ?

—Coverdale

For your R. F. E. research you might want to try an Electron Tube Division's portable microwave rf power source Model 218. Provides CW and MCW power variable from 50 to 500 watts or pulse capabilities varying from 50 to 2,000 watts peak power, 10 to 30,000 microsecond pulse length, and 10 to 10,000 cycles pulse rate. Operates within the frequency ranges from 475 to 725 and 915 to 9,475 mc/sec. Other applications: component testing, antenna range testing, and for use as a driver. More facts and figures available from the Marketing Department, Electron Tube Division, San Carlos, Calif.

ANSWERS TO LAST WEEK'S PROBLEMS: 46 different ways. Letting  $x, y$ , and  $z$  represent respectively the number of down votes from A to B, B to C, and C to A, we have the following equations:  $x + yz = 42$ ,  $y + xz = 62$ . These two equations give  $y = \frac{2(3z - 42)}{z - 25}$ , which gives rise to three values of  $z$ , 2, 3, and 11 with corresponding values: 47E, 30C, and 46. Only the latter meets the conditions of the problem.

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## FINANCIAL

### New Offerings

Ling-Tenou-Vought, Inc., Dallas, Tex., engaged in the design, development and production of airborne aircraft and missile, electronic products and electro-optical and acoustical equipment and other products. Offering \$4,877,500 of outstanding 1975 subordinated convertible debentures. 1976, for public sale by Jones & Lang vice chairman of the board. Mr. Ling also intends to sell from time to time all or part of warrants expiring in 1986 to purchase an aggregate of 25,000 common shares at \$10 and \$40 per share.

The debentures to be offered were received in part by Mr. Ling upon receipt of opinion sheets of Chance Vought Corp. issued in two in connection with the complete liquidation of Chance Vought. Following sale of its assets to the company in August, 1961, and in part issued to him upon completion of debentures of Chance Vought issued in 1961 and assumed by the company in connection with the purchase of said assets.

Sciencel International, Inc., Washington, D.C., organized in 1960, intends to establish manufacturing facilities to produce a complete line of benchtop products; the company has acquired a number of manufacturing facilities in a plant near Hialeah, Fla., and a number of testing products. Offering is 1,000,000 common shares at \$5 per share. Of the proceeds \$419,000 will be used for real estate and buildings, \$2,161,000 for equipment, \$991,600 for working capital.

GPTChemicals, Inc., Plattsburgh, N.Y., engaged in research, development and manufacture of electro-optical products and electronics instruments for defense and the military services, has previously placed \$175,000 of convertible subordinated debentures, due Feb. 1, 1972. Proceeds will be used for new product development, research, capital equipment and general corporate purposes.

New York Trading Laboratories, Inc., New York, N.Y., engaged in buying and analyzing electronic, chemical and other materials, standardized items and structures. Offering is 50,000 common shares at \$5 per share. Proceeds of the sale will be used to move the company's plant to Nassau County, N.Y. and to purchase new equipment for measurement and other testing including a random noise reduction system.

## AVIONICS

### Anti-Collision System Concept Reported

By Phyllis J. Kline

Washington—New details on a collision avoidance system technique based on the use of a precision airborne frequency reference were disclosed here last week by the National Co. at the Federal Aviation Agency-sponsored anti-collision system conference.

The company, which has filed for patents on the basic concept, is under FAA contract to conduct flight tests later this year to evaluate feasibility (AWM Jan. 7, p. 99).

The FAA also is interested in the possibility of using a precision airborne frequency reference in combination with Loran-C signals to provide long-range navigation service, Aviation Week has learned.

#### Frequency Reference

The concept of using an airborne frequency reference to measure separation distance and closing rate between two aircraft is a natural outgrowth of National's pioneering work in carrier-based atomic clocks, which the company calls Atomachron. However, the system required by National does not require the use of such precise frequency standards. It could use less costly crystal oscillators, providing good facilities are provided to give periodic calibration of the airborne reference.

An interesting feature of the new concept is that it could be expanded to also provide navigation and air traffic control service. However, FAA's

present interest is centered primarily on collision prevention capabilities. National's latest Request told the FAA conference that the proposed system will use the same collision-avoidance criteria originally proposed by Ronald Rada for its system (AWM Feb. 15, 1968, p. 67). This criteria is the use of accuracy-sensitive distance to closure rate. The idea is embodied by the Greek letter "Tau" or  $\tau$ , so that distance using this criteria often are called "Tau systems."

Both companies proposed that aircraft transmit a message which indicates its own transponder altitude. This enables other aircraft to determine if an intruder is at or near their own altitude, and thus whether it is a potential threat.

But instead of using the Rada ground-based ranging technique to measure aircraft separation, National proposes that each aircraft transmit a brief message at a precisely controlled, specifically assigned time slot. When an aircraft receives such a message from other aircraft within range, it need only note the time of message arrival with respect to its own frequency time standard and compare this with the last assigned transmit time slot to determine time required for message transit. This can be directly equated into distance between the two aircraft, with such a measurement of transit time being a proportional signal to 1,000 ft of separation.

While Rada decreases closure

rate by increasing the change of separation distance over a fixed hour as a result of rise, the proposed National system can automatically decrease closure rate by increasing Doppler shift of the received signal, again referred to its own frequency time standard.

But the National system requires that each potential aircraft be equipped with a frequency-time standard of sufficient accuracy to assure that a transmit procedure at its assigned time slot and at a constant carrier frequency for accurate Doppler shift determinations of closure rate.

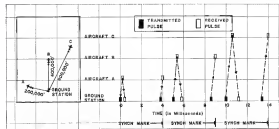
Either the airborne standard must have sufficient inherent stability, or it must be periodically recalibrated from ground stations.

#### Accuracy Required

An appreciation of the accuracy and stability required of the airborne frequency standard can be gained from the fact that an error of one microsecond (one millionth of a second) in the time that an aircraft transmits its message produces an error of 1,000 ft in determining its distance.

Additionally, an error of one microsecond in the timing of the airborne standard used by another aircraft which receives the message can introduce another 1,000 ft error in distance measurement of the two aircraft, assuming they are flying in opposite directions.

Crystal oscillators can be built using the best available techniques, with a drift rate of about one part in 50 bil-



NATIONAL CO.'S ANTI-COLLISION SYSTEM can ground station which measures distance to each aircraft using DME technique; then automatically transmits its transmission window to each aircraft as signal will reach the aircraft at a prescribed time.

ton per day. While this is a significant accomplishment for a cruise satellite it amounts to a drift of about one second over three hours.

For short duration dynamic flights with atomic clock calibration facilities at the airport or enroute the cruise satellite before take-off such drift rates should be adequate. But for long non-stop flights of six hours, the accumulated drift would be equivalent to a 2,000 ft. error or 4,000 ft. for two aircraft involved in a collision threat situation where both had been airborne for six hours without calibration.

Also drift in the airborne frequency standards would result in errors in receiving closing rate by Doppler shift measurement.

#### Small Atomic Clock

One solution for large aircraft would be to use an atomic clock whose drift rate is only 1/10th to 1/100th as much as the best quartz oscillator.

Based on performance design work, National believes it can build an airborne atomic clock fully autonomous which would weigh about 20 lb., except about one cubic foot and sell for approximately "several" thousand dollars in quantity production. It would have the stability of one part in 10<sup>10</sup> billion or better according to private estimates. Aviation Week was told "The cost per gram already has cut the price of atomic clocks significantly from their original figure of about \$100,000 to \$11,000 for a recent model produced in quantities of 10 units."

Using an atomic clock in each aircraft, the airborne station would need to be synchronized only once per day. This could be done quickly using a ground atomic clock matched at major airports while the aircraft was at the end of the runway waiting to take off.

But for smaller aircraft, an atomic clock may be too expensive and bulky.

National has devised an alternative which would use a low-cost airborne cruise satellite as a network of ground facilities for periodically synchronizing the cruise satellite. Such a calibration ground facilities, centered with precision atomic clocks, would be located at general aviation stations.

Here is how such a network might operate. Each aircraft normally is at a specific time slot for transmission to collision warning message. Present thinking is that the time slot would be about five or six seconds in duration. The message would include a series of binary coded pulses indicating aircraft barometric altitude. Each aircraft would repeat its warning message transmission once per second for perhaps nine aircraft, then transmit about for one second to receive ground

transmitted synchronization signals.

The purpose of this ground signal is to provide each aircraft with an accurate time marker from which it can check its onboard timing. For possible confusion drift to assure that each aircraft knows its subsequent recognition of the prescribed time slot.

If the ground station transmitted a single time marker signal to all aircraft simultaneously, it would arrive at each aircraft at a different time when each is at a different distance from the station due to signal travel time—up perhaps one microsecond per thousand feet.

One solution to this problem is to transmit an individual synchronization marker to each aircraft during its transmission so that it arrives at the intended aircraft at the desired instant. This requires that the ground station determine the distance to each aircraft which can be obtained if the aircraft transmits return or connected to function as a DME transponder during the synchronization period.

For example, during the synchronization period, each aircraft will transmit a pulse and so as to act as a transponder to any ground station in frequency assigned during its assigned time slot (during which it normally transmits its warning message). The individual aircraft transmits back the received pulse and the ground station can then determine its distance from the two-way transit time.

Knowing the distance to the aircraft, the ground station can then determine at what subsequent instant it must transmit the synchronization marker to that aircraft for it to arrive at the prescribed time. At the appropriate number of microseconds later, the ground station transmits the synchronization marker to this aircraft. If then repeats the cycle until a re-call of all assigned time slots and aircraft has been completed.

#### Alternate Approach

An alternate approach would be to have the ground station transmit a single synchronization marker to all aircraft at specified times and have the aircraft use its own airborne DME to determine distance to the station and to compensate for signal travel time.

Each ground station synchronization signal permits instantaneous synchronization of the airborne facilities but does not provide correction at the basic level itself. However, by timing and registering a sufficient number of such measurements, the airborne station could determine the approximate magnitude and direction of its oscillation drift and introduce necessary compensation.

Some observers believe that the system proposed by National faces difficult

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Precision, lightweight, high accuracy components with applications in analog computers and automatic control systems. The compensator winding provides feedback and torque for a resistor feedback amplifier, the feedback loop automatically adjusts to compensate for temperature and frequency variations. Functional error of the #3300-018 is only 0.1%. A compatible toroidalized amplifier, Model Number #3310-01A, is available.

Part Number	SPR-01	CVE 3300-000
Characteristics		
Resolution (per cent)	10	30
Frequency Range	0-50	0-50
Total Load Resistance	25	25
Max. Error from 1.2 (per cent)	5	5
Operating Temp Range (°C)	-55 to +125	-55 to +125

For complete data write Kearfoot Division, General Precision, Inc., Little Falls, New Jersey.

# KEARFOOT

## DUAL- CHANNEL TRANSISTORIZED BUFFER AMPLIFIERS

These high-performance units are designed to drive Kearfoot's Size 11 #3900 winding-compensated synchro resolvers. The amplifier/resolver combination has stable gain characteristics and negligible phase shift through an ambient temperature range of -50°C to +125°C. Extremely high resistance to shock and vibration. Meets environmental requirements of MIL-E-15572.

Part Number	#3310-01
Characteristics	
Number of inputs	4 per channel
Input Impedance (ohms nominal at 25°C)	100,000
Voltage Gain	1-10,000
Phase Shift (per cent input at 25°C)	0.1
Dist. Signal Output Voltage	25 volts
Com. Disturbance Over Drive Temp. Range	1-10,000

For complete data write Kearfoot Division, General Precision, Inc., Little Falls, New Jersey.

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in motion. Shortly after passing the second light stand in descent to 15,000 ft and not actuated via a shorter route to proceed on Victor 30 until intercepting Victor 121. This was causing confusion to the distance to the Phoenix Intersection by approximately 11 mi at 10. However, it did not affect the Phoenix descent route. The New York Center advised United 826 to maintain present heading from Minnesota, still intercepting Victor 30 and then descend in 10 minutes to maintain 11,000 ft. Subsequently, United 826 was advised by New York Center that it was crossing the center line of Victor 30. United 826 confirmed establishment on Victor 30 and reported to distance from Victor 121. The New York Center advised that the light was 16 mi from Victor 121 and about 2 mi from current Victor 418. This information, during the possibility of a misinterpretation of the Phoenix Intersection should have alerted the United crew of the rapid approach to the Phoenix turn.

After United 826 was established on Victor 30, the New York Center cleared the light to descend to 5,000 ft. United 826 acknowledged and reported leaving 14,000 ft. New York Center cleared United 826 to descend to 5,000 ft. United 826 was cleared to descend to 5,000 ft. United 826 was cleared to descend to 5,000 ft. United 826 was cleared to descend to 5,000 ft.

To ensure that United 826 understood the distance from the New York Center provided holding instructions for the Phoenix Intersection, the flight was altered in the time that the risk delay could be in the descent. United 826 reported leaving 1,000 and 6,000 ft. United 826 reported leaving 5,000 ft was acknowledged by the New York Center which then instructed the flight to maintain Midwest Approach Control. New York Center did not furnish radar vector to United 826. United 826 was cleared to descend to 5,000 ft. United 826 was cleared to descend to 5,000 ft. United 826 was cleared to descend to 5,000 ft. United 826 was cleared to descend to 5,000 ft.

This area which would normally be observed by the approach controller as a risk in order to identify aircraft approaching. Phoenix would have been from a similar direction. According to the position report transmitted by United 826, and the clearance issued by ATC, the approach controller would have identified, as reported to advise a rapid approach. No target was observed. Aircraft must be positively identified and radar contact established in the controller before radar vectors are transmitted. Radar radar contact is accomplished by visual means.

- By the aircraft reporting over a known area in which the controller has identified the target.
- By monitoring the heading of an aircraft

and reporting a turn to a designated heading for identification.

• A radar handoff would be effected in accordance with the same naming, the only exception being that both facilities New York Center and Midwest Approach Control would simultaneously observe the aircraft during these procedures. The radar facility would not relinquish control until the receiving facility had the aircraft properly identified. It was noted that radar handoffs in the complex vector flow traffic. There was not a standard in the air traffic control system. Radar handoffs were not in the discretion of the controller with radar communication between facilities in the event of an emergency. A radar handoff was not used in United Flight 121. Since United 826 did not advise ATC of a failure of a component of components of the No. 2 engine system in respect to the emergency, ATC could not assume that he was capable of providing his own navigation. There was no requirement to of left a positive radar handoff procedure between New York Center and Midwest Approach Control.

### Air Traffic Control

Victor 30 was 121, upon which United 826 was proceeding, it was noted and cleared to a new route, advisory service, Lake Geneva and Midwest Approach. Under VFR, aircraft transiting the area are controlled by the New York Air Route Traffic Control Center. Under VFR, weather conditions, aircraft may transit the area without an ATC clearance, in which event ATC would not have knowledge of such aircraft's position, altitude, direction, or identification. Further air traffic procedures do not apply for the operations of a tower, FFR, and VFR, traffic except as designated priority, control, airport. In view of the fact that the accident on the New York area on Dec. 16, 1960, during the period 1000 to 1100, was not conducted by VFR controller, it is highly probable that VFR traffic would have been transiting Victor 121 in approach, enroute, or on the line of all available technological information, it is concluded that the weather conditions in the New York area were such that between the altitude of 100 ft and 15,000 ft VFR flight would not have been possible.

The New York Center records indicate that there was no VFR aircraft operating in the New York Metropolitan area on Victor 121 during the period 1000 to 1100 on Dec. 16, 1960. Consequently, the aircraft observed as radar by Lake Geneva Approach Control would not have been radar observed as radar by two airports, but cleared by Midwest, as an unidentified aircraft. Since Lake Geneva Approach Control did not have a flight program report on the unidentified traffic, they were aware that the traffic on Victor 121 was not detected by three airports in order to identify the aircraft. The decision of the unidentified aircraft, the approach controller could not report the information from the New York Center. It is concluded that Lake Geneva Approach Control could have established communication with the New York Center, observed the aircraft, and transmitted information in accordance with the VFR. The only immediate alternative action that could have



Model #1100-018

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This encapsulated 5-watt amplifier, approximately one cubic inch in volume, Component elements are mounted in a high-density three-dimensional array, and leads are interconnected by resistive spot welding. This process assures extremely high reliability. High efficiency-weight ratio of the encapsulated amplifier makes it particularly suitable for mobile and high-speed aircraft engine fans under extreme shock and vibration.

Characteristics	
Maximum Power	-50°C to +125°C
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Supply Current	400 to 1000 ma
Gain	10 to 100
Input Impedance	100,000 ohms
Output Impedance	100 ohms
Operating Temp. Range	-55 to +125°C
Shock	1000 g's for 10 ms
Vibration	1000 g's for 10 ms

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# A CHALLENGE OR A COUCH?

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Radar Systems	Operations Analysis	Applied Research
Computer Design	Digital Mechanics	RF Equipment Design
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into action by the LaGrange Approach Controller would have been to provide correct radar action to TWA 266 on the assumption that the unidentified traffic was transiting traffic. This provision of radar action to TWA 266 would not be correct based on the controller's assumption as the aircraft in the area in which TWA 266 was operating had been assigned to LaGrange Approach Control.

The New York Center RMA Radar Controller's broadcast that he observed United 525 on his scope one to three miles north of Peconic at the time the flight reported out of 6000 ft is inconsistent with the facts concerning the time of collision. It must be recalled that the controller's moment of the position of United 525, at the time of observation, is in error. If he were correct there could not have been a collision at the time and place it occurred.

The Board concludes from the findings that the controller did not observe 525 at the location.

The transcription "No. 2 transponder error occurred and out" has been noted the question as to its proper meaning. As an operator's action cannot be a true action until it is properly assigned to the DCA, it appears that the description of the collision was actually the VOR transmission in which the aircraft on which the collision occurred was operating. The transponder was not used on the DCA would have been on the radio around the VOR frequency No. 2 transmission and the fact that the location of the collision as both aircraft was basically the same. Assuming that this was an accident due to a loss of position, the fact having effect might have been observed by the crew.

Condition One  
VOR NAV 2 115. Ground Station (G)  
Run 11.00

Indication to Crew  
a No. 2 PTH not working flag visible  
b No. 2 RMI VOR (double barrel)  
position drift  
c No action taken

Condition Two  
VOR NAV 2 115.4. Ground Station (G)  
Run 11.00

Indication to Crew  
a No. 2 PTH not working flag visible  
b No. 2 RMI VOR (double barrel)  
position drift  
c No action taken

Condition Three  
First officer's landing wheel lock light goes on

Indication to Crew  
a No. 2 PTH not working flag visible  
b No. 2 RMI VOR (double barrel)  
position drift not reported in change  
in heading or frequency position

Condition Four  
VOR NAV Transmitter No. 2 Circuit Breaker Open

Indication to Crew  
a No. 2 PTH not working flag visible  
b First officer's RMI VOR and No. 2 RMI VOR (double barrel) position drift not reported in change in heading or frequency position

These conditions were taken the result of a traffic alert or warning resulted in a red warning flag, upon which the controller advised the crew that the aircraft had a loss of communication or a malfunction in the cockpit that the crew would be required



## Wings Mated to Short Skyvan Transport Prototype

Wings have been mated to the Short Skyvan transport prototype now being built by Short Brothers & Harland at Belfast, Northern Ireland. Test flight is reportedly scheduled for this summer, but should be delayed and the airplane will not be shown at the annual Farnborough Air Display in September (AV 36 p. 27). Propellers will be two Continental GTS 30-350 engines.

the fuselage without the appearance of a red warning flag.

From the clearance to Victor 30, United Flight 525 had been cleared Alderboro VOR direct Robinsonville VOR. Accordingly, the flightpath after passing the Alderboro VOR was projected on the basis of a turn to a direct heading to Robinsonville VOR and this heading intersected and intercepted Victor 30. The transcription indicates that the aircraft was established on Victor 30, and in 1029.51 was given a position from the New York Center in response to two radar returns from receiving Victor 30. It is assumed that the aircraft would be flown within the radius of Victor 30 around the heading to intercept Victor 30. In considering that one VOR course may have been requested to the two other Victor 30 as well as a heading turn to the 090 deg radial at Robinsonville, in order not to violate the conditions of Victor 123. From the point of interception of Victor 123 the flightpath was projected in a straight line to the collision point estimated at approximately 6.915 ft above the surface of Alderboro on a bearing of 154 degrees. The flightpath was derived independent of the flight recorder information.

Condition One  
VOR NAV 2 115.4. Ground Station (G)  
Run 11.00

Indication to Crew  
a No. 2 PTH not working flag visible  
b No. 2 RMI VOR (double barrel)  
position drift  
c No action taken

Condition Two  
VOR NAV 2 115.4. Ground Station (G)  
Run 11.00

Indication to Crew  
a No. 2 PTH not working flag visible  
b No. 2 RMI VOR (double barrel)  
position drift  
c No action taken

Condition Three  
First officer's landing wheel lock light goes on

Indication to Crew  
a No. 2 PTH not working flag visible  
b No. 2 RMI VOR (double barrel)  
position drift not reported in change  
in heading or frequency position

Condition Four  
VOR NAV Transmitter No. 2 Circuit Breaker Open

Indication to Crew  
a No. 2 PTH not working flag visible  
b First officer's RMI VOR and No. 2 RMI VOR (double barrel) position drift not reported in change in heading or frequency position

These turns in heading were properly corrected.

Accordingly, a ground speed of 300 ft was considered reasonable in projecting the probable path of flight while being received and the path was plotted on the charted collision point back to Victor 30 intercept heading of 090 deg, 180 deg, and 315 deg.

The track of collision indicated is not in conflict to show that this is the precise time of collision in order to have a starting point for the purpose of establishing approximate geographical positions at one-minute intervals. 1029.51 was selected as a reasonably close enough figure for the following reasons: It marks a definite point in the transcript of the transcript, i.e., the end of the open circuit.

Condition One  
VOR NAV 2 115.4. Ground Station (G)  
Run 11.00

Indication to Crew  
a No. 2 PTH not working flag visible  
b No. 2 RMI VOR (double barrel)  
position drift  
c No action taken

Condition Two  
VOR NAV 2 115.4. Ground Station (G)  
Run 11.00

Indication to Crew  
a No. 2 PTH not working flag visible  
b No. 2 RMI VOR (double barrel)  
position drift  
c No action taken

Condition Three  
First officer's landing wheel lock light goes on

Indication to Crew  
a No. 2 PTH not working flag visible  
b No. 2 RMI VOR (double barrel)  
position drift not reported in change  
in heading or frequency position

Condition Four  
VOR NAV Transmitter No. 2 Circuit Breaker Open

Indication to Crew  
a No. 2 PTH not working flag visible  
b First officer's RMI VOR and No. 2 RMI VOR (double barrel) position drift not reported in change in heading or frequency position

These conditions were taken the result of a traffic alert or warning resulted in a red warning flag, upon which the controller advised the crew that the aircraft had a loss of communication or a malfunction in the cockpit that the crew would be required

in 1029.51 from that point using the information obtained from the flight recorder system. The transponder position was derived and plotted back along the flight path to Alderboro.

The data points were then placed in a fixed curve.

Flight recorder tapes of selected flights making ILS approaches under conditions similar to those at New York, Lincoln Tunnel, Airport from the area of Victor 30 and Victor 123 between Dec. 5 and Dec. 15, 1965 were plotted. Only one of the 31 computed ground tracks indicated a holding pattern at Peconic. Most of the remaining tracks indicated turns of 90 or 180 degrees around Peconic. However, possible track maneuvers resulting from loss of communication in selected flights, headings and possible differences between actual and reported wind speeds, possible determination of the exact distance from Peconic at which these turns were made.

## VOR Interference

United States Flight 525 did not enter a holding pattern at Peconic. Interference had occurred southeast on Victor 123. This raised the question of the reliability and integrity of the VOR radio navigation equipment from New York, New York, and Boston which also has the Peconic Interference. New Orleans has been advised to explain how accurate compass information could have been obtained at Peconic at the time of the accident. It has been suggested that false radar return information received at Peconic and could have been caused by extraneous interference, inaccurate radar return reflections, scattered information and a compass malfunction.

To approximate and evaluate such things, a brief review of VOR operating principles is presented.

VOR stations at the above three locations are operated and maintained by the Federal Aviation Agency and transmit signals in the radio frequency radio spectrum. Each station is limited to a specific frequency. The station is limited to the

relying equipment located a desired bearing or coordinate which may or may not be the optimum station. A 150-psi signal radiates from antennas located beneath a cross which is located in the middle of the main display. The bearing information is transmitted as signals that are unique for each aircraft. Should a signal of specific bearing production be changed from its proper track, it will be noted affecting phenomenon of visual information in original bearing information tag together with its final placement. A main display device which is attached to the main display area shows the proper personnel in "dramatic" when receiver signal character starts change when the bearing information is in error, plus it means one degree, and when this signal is not present. In addition, the receiver immediately shows the time, either all when in the area or not. There was no sound at all of such a magnitude as any of the above facilities in the time of the accident.

The pattern of signal strength developed as space in the display allowed of specific data, thus increasing and signals reflected by the coordinates. In addition, reflection of the signal by the earth contribute to the form of the signal strength pattern. The varying nature of the signal will cause the pattern to differ slightly with each aircraft. With two levels and buildings are reflected on the reflecting surface of the earth. A weak signal in the signal pattern is called a "null" and the pattern of signal strength is called a "hole". The relative quality of the signal surface, visual, but usually the strength of signal reflected in line in comparison with the data signal to that station in the earth's

reflecting ability would result in slight changes in the signal pattern. Therefore, the ground pattern of the VOR signal strength is a hole filling the space around the station from the horizon to an altitude of approximately 75 deg. The nulls, the signal strength is the signal about a station and a measurable signal is developed 30 deg. to 15 deg. either side of the vertical plane of the station. This will be noted the case of aircraft.

The area distribution of space on the coordinate was a very small change in the signal pattern. This was noted at the second public hearing, which stated that approximately two miles of space were in the coordinate of the Ohio New VOR signal. This was the reason. Yet, the results conducted by the FAA during the winter of 1969 concluded that although some of the coordinate is undesirable, it is not a serious source of error within the height of space exceeds the height of the station (approximately 45 ft).

The reason of increased surveillance against the possibility that radio VOR station operating on the same frequency in Ohio New VOR station is such as to cause, phenomenon into the present area. That is, the Ohio New VOR station is in the United States and because of the limited number of radio frequencies available, the radio frequency must be occasionally assigned to some other use. However, since radio signals in this frequency spectrum are transmitted, only as an approximation, one of eight parts, the difficulty of during frequency is eliminated by placing stations using the same frequency a great distance apart.

Throughout it is possible to receive signals of the radio band over a distance substantially greater than the line of sight path, but sometimes below, that required conditions or such occur and then only occasionally during the winter months. Nevertheless, morning that with a phenomenon of cost on the 10, the modern signal form of the combination of two different station results would depend on the quality of the signal of the same information, the receiver, plus for each transmitter and on the phase of the radiated bearing information to have a double signal. The such combination phenomenon to occur over the distance, and station from the United Flight 625 as it is not through the Texas area, it is usually highly susceptible.

Several individual personnel who have a negative radio signal, however, of which will be the VOR frequency band. The results of such a signal is known to have occurred in the New York City area and the strength of such signals would permit their reception in the present area. The possibility that such signals caused erroneous bearing information to be received by the United Flight is extremely unlikely. As such, the flight is not a factor in the United Flight over Texas. Its loss and seven minutes respectively, reported as a reference.

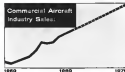
The possibility of interference to the proper reception of VOR signals would be other than radio signals such as those transmitted by the Voice of America station, WGBH, at a specific location, and considered. Flight checks of the VOR in the Texas defense Division, with WGBH operating at the frequency and power used

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at the time of the accident, based on its degree of interference.

One of the most serious problems that can arise once a satellite is in orbit is the problem of a signal of its own motion with the earth. To aid in tracking this possibility the Galt-Nack unit was loaded in landscape, structure at dusk, which could not be detected by the telescope. A signal was a full in its own motion, however, the telescope's field of view was not wide enough to see the signal. There was no signal to be seen, but the signal was difficult to see.

While on route from Houston to Redwood, Flight 525 received an incoming message from Victor 10 and to intercept Victor 123 with further details to be expected at dusk. The signal was a full in its own motion, however, the telescope's field of view was not wide enough to see the signal. There was no signal to be seen, but the signal was difficult to see.

At dusk, the signal transmitted by a VOR station in Redwood was horizontally polarized. However, some vertical polarizations occur even in a small degree. The vertically polarized wave component of a signal is transmitted in the same direction as the horizontally polarized wave, but in a different direction. The signal transmitted by a VOR station in Redwood was horizontally polarized. However, some vertical polarizations occur even in a small degree. The vertically polarized wave component of a signal is transmitted in the same direction as the horizontally polarized wave, but in a different direction.

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RHII would allow opening a ready point to 160 deg on the VGR, exactly at the time of prong Preton. The crew would be surprised to find themselves in 4-5 sec.

If the No. 2 VGR actually met with disruption, the captain would see the No. 1 VGR and the RHII on Robinsonville and report to us. The double prong on the No. 1 VGR pointing to 160 deg on the rotating azimuth wheel among Preton and at the same time the captain's FDI would be indicating the timing of Preton. It is believed that since Goff Nook is definitely operating normally, and that the crew had noted this facility stable operating the flight on Victor 12, it would have been the logical and in calculating the Preton fix. Since it is believed that the ADI was used for navigation, it is probable that the captain was functioning to the ADI and naturally associated this instrument with the VGR RHII. In such a case he would realize, he might said the No. 1 pointed at the ADI indicated 160 deg on the RHII. With the No. 1 VGR turned to 160 deg, the captain would then the only possible one indicating approximately 160 deg and had not moved the entire earth 160 deg. This coupled with the fact that the crew had observed approach control that they were coming up as Preton that the altitude at time of collision was a little over 1000 ft, that radio contact had been interrupted, and that the crew had not reported over Preton, all tend to support the conclusion that the crew knew they had not yet reached the Preton Intersection where the collision occurred.

Also the flight had occurred on the 090 deg radial of Robinsonville while proceeding northwesterly and while descending. Some crew, as reported. The two to point of collision was exactly the same in time actually required to fly from Robinsonville to Preton. The distance from visual observation of Victor 125 (at the distance to Robinsonville to Preton is approximately the same distance that the flight made from approaching Victor 125 to Victor 14 to the crash site. Therefore, the time to travel from Robinsonville to Preton would approximate the elapsed time from Victor 10 to Victor 14 to the crash site.

The Board believes with the above, no further proving the captain would be operating the controls depending upon the cockpit to have the required approach at around new clearance, and keep him advised of other operations that it is further believed because the captain was operating the No. 1 VGR pointing and the FDI was turned to Robinsonville frequency, to maintain his position on Victor 125, and hold it accurately.

The crew had flown this or other man, been told very little with the time and distance from Robinsonville to Preton. Also, at the Preton Intersection and could be Goff Nook, the captain, when negotiating with both VGR units, was concerned to bring the No. 2 VGR pointer in a southward direction and in accordance with the No. 1 or captain's VGR master. The second display by the captain's ADI when used to Scotland with the second over the crash site would conclude the captain's view at a Preton with the No. 2 VGR turned to Goff Nook. The Preton Intersection

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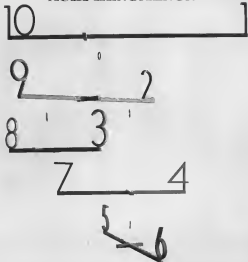
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would be identified while holding its mechanical output of 210 deg. of Rollback rate and by a 100 deg. indicator in the RMI track to Scotland. It is assumed that the New York area charts do not indicate westerly, the heading of Scotland Area Fusion, but by comparison a vice closing up possession of the current bearing could be obtained.

From the foregoing, the board concludes that the cum of United 330 did not take into the change of time and distance which would be associated with the new elements, and possibly, caused the A29 display with the anticipated VOR display thereby exceeding the distance limit.

The board concludes that while with this type aircraft it is possible to navigate with one VOR navigational unit, the lack degree of cockpit occupation during the approach to Porton intersection indicates that a second capable VOR unit would have control as a positive identification of the Porton Intersection. The change of element from the original "Missions, do not 330s for Victor 123 to Fusion," to the short cut element "present heading, is Victor 30, Victor 10 to Victor 123 to Porton," added to the workload of memory and reprogramming the navigational problem during a very small interval of time.

The board further concludes that the New York Center controller did not observe United 330 procedures through the Porton Intersection before he had cleared the flight to conduct Internal Approach Control and prior to the transmission of radar service. When radar service was being provided at 101520, Flight 330 had already provided light or vice radar beyond Porton.

United 330 acknowledged the radar service at 101525, shortly before the collision.

### FAA Action

The board notes that during the course of the investigation the Federal Aviation Agency took various steps to improve and strengthen the efficiency and effectiveness of its Air Traffic Control System, including the following:

- A recent regulation (SR-145) was issued which requires pilots operating under instrument flight rules to report in flight altitudes in increments of 1,000 feet or 500 feet, as appropriate.
- A program has been established for all towers to provide a "look down" service which requires pilots operating under instrument flight rules to report in flight altitudes in increments of 1,000 feet or 500 feet, as appropriate.
- Radar handoff service for arriving and departing aircraft in the New York area is being performed in a much greater extent than ever practiced before the accident. On a national basis, full-time radar handoff service has increased to a great extent.
- Controllers have been instructed to pass an advisory in arriving air traffic to "clear" to holding pattern around at least 10 miles before reaching holding fix.
- The branching P-1, VOR, and radar identification signal (SR1) have been changed in Tusconville (TVC) because of potential confusion with holding VOR (SR1).
- The Agency has issued a special rule to hold

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publicly access from covering 250 ft and within 30 feet of a detonation agent and below 10,000, except where the safety equipment of tested ordnance may achieve a higher minimum speed, which then applies to these altitudes.

#### Probable Cause

The Board determines that the probable cause of the accident was that United Flight 152 proceeded beyond its clearance limit and the confirm of the request allowed to the flight by Air Traffic Control. A contributing factor was the high rate of speed of the United DC-8 as it approached the Puerto Rico intersection, coupled with the change of clearance which reduced the thrust distance along Victor 123 by approximately 11 mi.

By the Civil Aeronautics Board:  
Alan S. Reid, Chairman,  
Robert T. Murphy, Vice Chairman,  
Chas. Casey, Member,  
G. Joseph Martin, Member,  
Whitney Gilchrist, Member

#### Investigation and Hearing

The Civil Aeronautics Board was notified that there was apparently an aircraft collision over Staten Island, New York, approximately 1950, Dec. 18, 1990. Investigation was immediately conducted from the Washington office to call the New York office investigators who were already on the scene. The investigation was initiated in accordance with the provisions of section 701(a)(1) of the Federal Aviation Act of 1958.

A public hearing was called by the Board and was held in the ballroom of the Sheraton Manhattan Parkside, New York, on Jan. 4 through Jan. 13, 1991. Seventy-two witnesses were subpoenaed and a large amount of documentary material was introduced in evidence.

A second public hearing was held at Civil Aeronautics Board Headquarters in the United Nations, 3255 Connecticut Avenue, Washington D. C., on July 21 and 22, 1991, at which time fifteen additional witnesses were interviewed and several witnesses re-called. Additional exhibits were introduced into evidence.

#### Air Carrier, Personnel

United World Airlines, a Delaware corporation, is a scheduled air carrier with principal offices located at Kenosha, Wis. It possesses a currently effective certificate of public convenience and necessity issued by the Civil Aeronautics Board and is an active operating certificate issued by the Federal Aviation Agency. These airlines are the carrier in question in this case, property and mail are various routes throughout from Dayton, Ohio, to New York, N. Y.

United Air Lines, Inc., a Delaware corporation, was an associate office in Chicago, Ill. The company is engaged in transporting by air persons, property, and mail. It holds a currently effective certificate of public convenience and necessity issued by the Civil Aeronautics Board and an active operating certificate issued by the Federal Aviation Agency. These airlines operate over a number of

routes including that of Los Angeles Calif., to New York, N. Y.

Capt. David A. Wicken, age 39, was employed by Trans World Airlines on May 21, 1948. He held a valid aircraft certificate with a currently effective airline transport certificate No. 250468. His ratings included DC-3, Martin 221 and 404 and Lockheed Constellation aircraft. Capt. Wicken had a total of 14,083 flying hours, of which 387 were as the Captain. He qualified in the type of equipment on Sept. 9, 1951. He was current in the requirements of proficiency checks, line check route qualifications, and recurrent training. He last FAA physical was passed on Oct. 31, 1968.

First Officer Dean T. Bowen, age 32, was employed by Trans World Airlines on July 17, 1955. He held a currently effective airline transport certificate No. 126217. He was rated as Lockheed Constellation aircraft.

First Officer Henry had a total of 6,411 flying hours, of which 387 were in the Constellation. He qualified as that type equipment on May 15, 1959. He was current in all Federal Aviation Agency and company requirements. He last Federal Aviation Agency physical was passed on Sept. 17, 1968.

Flight Engineer LaRue J. Renscher, age 36, was employed by Trans World Airlines on Jan. 1, 1956. He held a currently effective airplane and propeller certificate No. 1252613 and flight engineer certificate No. 1340774. He was qualified in a flight engineer with the company on May 9, 1955. He had a total

of 1,561 flying hours of which 204 were in Constellation equipment.

Severance Marine Coast, age 26, was employed by Trans World Airlines on Oct. 15, 1951. Severance Marine Coast age 21, was employed by Trans World Airlines on Jan. 1, 1960.

#### UAA, Flight Personnel

Capt. Robert W. Farnsworth, age 45, was employed by United Air Lines on Dec. 2, 1948. He held a valid aircraft certificate with a currently effective airline transport certificate No. 20877. His ratings included DC-3, B-247, DC-4, DC-6, DC-7 and DC-8 type aircraft. Capt. Farnsworth had a total of 10,560 flying hours, of which 544 were in DC-8 type aircraft. He qualified as DC-8 type aircraft on June 4, 1968. He was current in the requirements of proficiency checks and was qualified in the last Federal Aviation Agency physical certificate was on Sept. 20, 1969.

First Officer Richard W. Farnsworth, age 40, was employed by United Air Lines on May 1, 1955. He held a currently effective airline transport certificate No. 490363. His ratings included DC-4, DC-6, DC-7 and DC-8 aircraft. First Officer Farnsworth had a total of 5,800 flying hours, of which 415 were in DC-8 type aircraft. He was rated as DC-8 aircraft on Jan. 1, 1960. He last Federal Aviation Agency physical was on Aug. 21, 1969.

Second Officer Richard W. Farnsworth, age 38, was employed by United Air Lines on Sept. 13, 1945. He held a currently effective certificate, No. 111117 and flight engineer certificate No. 1259080. His ratings included DC-6, DC-7 and DC-8 type aircraft. Second Officer Farnsworth had a total of 5,150 flying hours, of which 579 were in flight engineer in DC-8 type aircraft. He was rated as DC-8 type aircraft on Dec. 15, 1959. His last FAA physical was on Oct. 24, 1969.

Severance Marine J. Seabright, age 24, was employed by United Air Lines on Dec. 10, 1955. Severance Marine M. Seabright, age 29, was employed by United Air Lines on Aug. 21, 1954. Severance Marine A. Seabright, age 26, was employed by United Air Lines on July 24, 1960. Severance Marine L. Seabright, age 25, was employed by United Air Lines on May 30, 1956.

#### Trans World Airlines Aircraft

N 4907C, a Lockheed Constellation model 8-1049A, manufacturer's serial No. 4870, was delivered to Trans World Airlines on Oct. 16, 1952. At the time of the accident, it was still in the serial of 21,551 flying hours. A line maintenance inspection had been conducted 249 h prior to the accident. The aircraft had been flown 3,991 h since its last overhaul. The aircraft was equipped with Wright engines model WND-97C1DC8-1 and Hercules Whittaker propeller model 49R04 with model 49R-1 blades.

#### United Air Lines Aircraft

N 5071U, Douglas DC-8, manufacturer's serial No. 4574, was delivered to United Air Lines on Dec. 12, 1959. At the time of the accident, the aircraft had a total of 2,454 flying hours. The aircraft had been flown 42 h since the last overhaul. The aircraft was equipped with Pratt & Whitney JTTC-6 turbojet engines.

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## Merger Comment

As Chairman of the American Rocket Society, Francis Conner and Co-Chairman of the Working Group on Fusion in the ARS-ASX Consolidation Steering Committee, I would like to comment on your article "Fusion: Learn to Merge Fusion After ARS-ASX Consolidation" in the June 18 issue (p. 25) of *Aerospace Week*.

From the ARS standpoint and I feel sure from the ASX standpoint as well, we are not juggling as many balls as financial critics. Also as a few financial health-care fans that are just about 32 years old and don't know and anticipate a "usable past and future" in 1963 apparatus—contrary to the contention you have attributed to Mr. Norr. The recent issue of a small ARS bulletin in the Proceedings of Consolidation document has given rise to some misunderstanding of the ARS financial position. I would like to take this opportunity to clarify it.

Several years ago the ARS' governing body elected the society to closely monitor member dues growth at "defensive" levels. Therefore, instead of ordering \$300 as received, when a member pays his dues we enter \$160 per month throughout the year. But it not been for this discounting charge, ARS would be a serious financial problem today. We have over \$250,000 on our list of "defunct member" charges.

As a matter of principle, the ARS Board never votes for that it was desirable for the society to accumulate large financial holdings. It certainly would have been a great idea to be merely holding down capital loss on member shares.

To give you an idea of the maintenance work with which the Board has authorized these expenditures, I will have a tabulation of the costs over the past year and projected through 1963:

Dollars	Members	Dollars	Special
	(per month)		(per month)
1959	560,000	1,200	526
1960	137,000	1,800	46
1961	220,000	1,500	45
1962	401,000	3,300	83
1963	441,000	7,900	81
1964	693,000	11,400	79
1965	829,000	17,100	68
1966	1,246,000	17,600	71
1967	1,278,000	26,900	67
1968	1,714,000	23,500	71

(Total)  
\*ARS dues.

A surplus has been budgeted for 1962, and in the first six months of the year the budget has been surpassed substantially. In my view, the society is very healthy in the financial state that most widely affects the financial state of any professional organization. Membership continues to up 21% the first six months of 1962 over 1961. After being down a year, and, as you know, most engineers in the aviation and space field are down in advertising. We expect a new record from industrial displays at the 17th Annual Meeting in Las Vegas, Nov. 15-18, as we received last year from the

*Aerospace Week* welcomes the opinion of its readers on the issues raised in its magazine's editorial columns. Address letters to the Editor, *Aerospace Week*, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 300 words and give a positive identification. We will not print anonymous letters, but names of writers will be withheld on request.

Space Flight Report to the Nation in the New York Column. Further the club will be considerably less (tenderness, the ARS club on exhibits has not previously shared the ARS Space Flight Exposition because ARS computer has required it as a requirement for the membership field.)

We're very glad to note your contentment in the merger proceedings. ARS is organizing a forum on the merger during its Lower Midwest Meeting in Cleveland, it will be held at 118 p.m. on Wednesday, July 18, at the Park Hotel Hotel. We hope Secretary Weiss will be there.

ROBERT A. GAGAN  
Chairman  
ARS-PASSEX Committee  
Co-Chairman  
ARS-ASX Working Group on Fusion

## Thrust Error

Small mistakes in rocket engine AVE June 25 p. 14

Correct thrust rating for F1 engine is 1.5 million lb. yet 130,000 lb. We need more power we can get—don't take any.

CHASMAN SARGENT  
Philadelphia, Pa.

(Reader Service is correct, and ARS # 22 publishes to North American Aviation's Rockwell Division, which recently announced that it is 1 million lb. yet 130,000 lb. as the test stand at Edwards AFB with the lower measuring equipment (DME) for Jan. 1, 1961. You see later, all credit of over 12,000 lb. maximum thrust weight must be as compared.)

## Satellite Tracker

We at Ark read with interest and pleasure the story on p. 15 of the first 10 min on the Satellite Tracker at AFVTC. We were especially interested because our own personnel and those of research and development, Dr. D. E. Marshall, was responsible for the design and development of the 240 in. dual length telescope, which is the key element of the tracker. When Dr. Marshall was at AFVTC, he was at the Physical Research Laboratory, a group of scientists who have developed the idea of using a laser-Galileo Optical System and making the optical path via vacuum to reduce the physical dimensions of the scope to less than 10 ft. The same group, now at Ark, is currently engaged in similar telescope design program.

Of additional interest is the fact that the rocket motor recently made the first pass of the New York Times when it was used to track the TV audience the people were in orbit of the first Gemini mission. Originally built for

the Aerial Reconnaissance Laboratory, Wright Patterson Air Force Base, the rocket is currently being used by a group at Edwards Air Force Base under the direction of Wd. to 10. Manning, Jr., to study satellites. Its sensitivity and tracking power are so great that it is called M3. Manning's group is doing the length of the satellite from pictures taken through the telescope.

Your article is evidence of a second interest on the part of many in the public in the use of photo-optical systems with image collectors for image instrumentation and computer photography. Along these lines we, together with other companies, are engaged in a number of in-house research and development programs to increase the sensitivity of laser TV systems by improving optical fiber tubes and other related electronic devices. Accordingly, we would be most interested in reading more articles in *Aerospace Week* on this subject.

HOWARD H. J. WERN  
Pattern Planner  
Bell Corp.  
Langhams, Mass.

(Samuel Weiss and Bruce Tressway market will remember that the photo-optical system of the AFVTC satellite tracker, showing broader image detail and separation from the Allen model which powered L. G. Scott Caperton's Mercury capsule, was published in the June 4 issue, pp. 357-361.)

## Regulation Rap

AVIATION WEEK's survey (June 18, p. 19) of CAA's GALT/FAA 1961 New York incident explained a previous point of CAA's which said that a program has been established (by FAA) for all future powerplant tests to be equipped with data recording equipment (DME) for Jan. 1, 1961. You see later, all credit of over 12,000 lb. maximum thrust weight must be as compared.)

Whether at CAA's working "program" or at the newly announced intention is that there is no FAA regulation now in existence requiring DME to be added into aircraft by some firm.

Facts indicate that there was a Notice of Proposed Rule Making by FAA on May 19, 1961, which proposed testing data for aircraft would be required with DME. Industry commented on this proposal.

This proposal (DME Rule 5810) has not been acted upon by FAA.

CAA still is confused over what has been FAA proposed in what has been FAA's action against this matter, provide one of the present FAA regulation on all aircraft which has been used in the last six months of the year 11. Notice of Proposed Rule Making, proposed to be in effect of 1961, is all of 1959 and 1960 and 17 in all of 1959.

WILLIAM K. LORING  
Executive Director  
National Business Aircraft Assn.  
Washington, D. C.



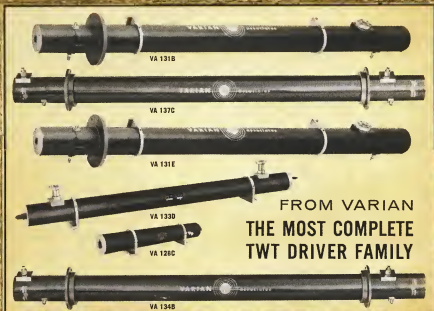
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VA 137C	0.87-1.00	5	350	600	45	PPM	Grid
VA 133D	1.25-1.40	5	350	600	50	PPM	Grid
VA 131E	1.25-1.70	25	150	35	35	PPM	Grid
VA 131B	1.25-1.70	50	200	30	40	PPM	Grid
VA 126C	2.9-3.35	5	15	10	30	PPM	Grid
VA 126A	5.26-5.90	5	10	10	50	Solenoid	Cathode Pulsed



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